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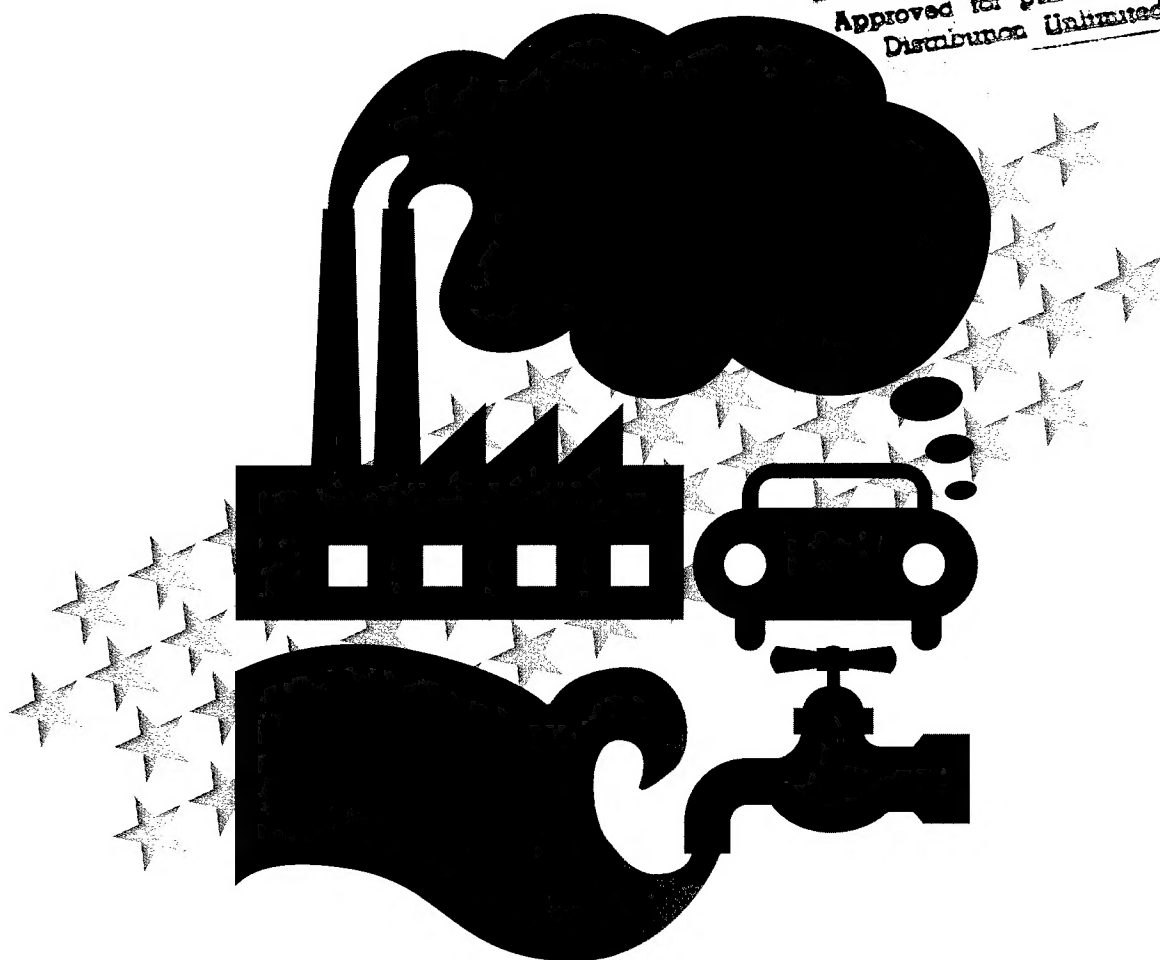
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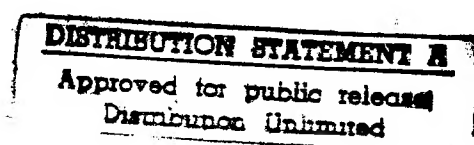
Federalism
and Environmental
Protection:
Case Studies for
Drinking Water and
Ground-Level Ozone



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**FEDERALISM AND ENVIRONMENTAL PROTECTION:
CASE STUDIES FOR DRINKING WATER
AND GROUND-LEVEL OZONE**



The Congress of the United States
Congressional Budget Office

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Preface

The federal government's role in making decisions about environmental protection has expanded greatly since the early 1970s. In recent years, however, the Congress has considered returning some decisionmaking authority back to state and local governments. An important question when assigning decisionmaking authority is, Which level of government is most likely to make decisions that balance all the relevant benefits and costs?

In response to a request from the Chairman of the Senate Committee on Environment and Public Works, this study examines several considerations that might help determine which level of government is most likely to make efficient decisions with regard to environmental protection. Those considerations are then applied to two case studies, the protection of drinking water and the control of ground-level ozone—the principal ingredient in smog.

Terry Dinan and Natalie Tawil of the Congressional Budget Office's (CBO's) Natural Resources and Commerce Division wrote the study under the supervision of Jan Paul Acton and Roger Hitchner. CBO analysts Kim Cawley, Marjorie Miller, and Pepper Santalucia made valuable comments, and Carl Muelmann provided assistance with data analysis. Outside CBO, Nancy Brooks, Maureen Cropper, Wallace Oates, and Paul Portney made helpful comments on various sections. In addition, several staff members of the Environmental Protection Agency's Office of Drinking Water and Office of Air Quality Planning and Standards provided useful information.

Paul L. Houts edited the manuscript, and Melissa Burman provided editorial assistance. Rae Wiseman typed the drafts. Kathryn Quattrone and Jill Sands prepared the study for publication. Laurie Brown prepared the electronic version for CBO's World Wide Web site.

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Director

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Contents

	SUMMARY	ix
ONE	ECONOMIC THEORY OF ENVIRONMENTAL FEDERALISM	1
	Defining Economic Efficiency 2	
	Choosing the Extent of Environmental Control 2	
	Deciding on the Methods of Pollution Control 10	
	Determining and Funding the Basic Research Agenda 14	
TWO	CASE STUDY OF DRINKING WATER PROTECTION	17
	Choosing Drinking Water Standards 18	
	Deciding on the Methods of Treatment 30	
	Determining and Funding the Basic Research Agenda 32	
THREE	CASE STUDY OF GROUND-LEVEL OZONE CONTROL	35
	Background 35	
	Choosing the Extent of Ozone Control 38	
	Deciding on Methods of Control 47	
	Determining and Funding the Basic Research Agenda 51	
FOUR	CONCLUSIONS	55
	Choosing the Extent of Environmental Control 55	
	Deciding on the Methods of Pollution Control 56	
	Determining and Funding the Basic Research Agenda 57	
APPENDIX		
	Is Federal Involvement in Inspection and Maintenance Programs Needed for Efficient Outcomes? 59	

TABLES

1.	Considerations Indicating Whether Centralized or Decentralized Decisionmaking Is Likely to Be More Efficient	4
2.	Welfare Effects per Household of Meeting the Proposed Standard for Adjusted Gross Alpha Emitters	26
3.	Number of Systems Exceeding Concentration Levels for Adjusted Gross Alpha Emitters	27
4.	Number of Households Exceeding Concentration Levels for Adjusted Gross Alpha Emitters	28
5.	Average Cost per Household for Monitoring and Compliance, by Size of System and Number of Treatments	29
6.	Requirements and Deadlines Under the 1990 Amendments to the Clean Air Act	40
7.	Potential Gains in Efficiency from Reallocating Emission Reductions	44

FIGURES

- | | | |
|----|---|----|
| 1. | Number of Counties in the Ozone Transport Region Predicted to Exceed the One-Hour Standard When the 1990 Amendments to the Clean Air Act and Ozone Transport Commission Controls Are in Place | 43 |
| 2. | Annual Cost-to-Benefit Ratio at the State Level as a Result of Regionwide Emission Control Programs | 45 |

BOXES

- | | | |
|----|---|----|
| 1. | Financing Environmental Improvements | 3 |
| 2. | Government Involvement in Choosing Methods of Pollution Control | 11 |
| 3. | The Ozone Transport Commission Agreements | 42 |

Summary

In 1970, the federal government established the Environmental Protection Agency (EPA) and began to take over a large part of the decisionmaking responsibility for environmental protection that had previously belonged to state and local governments. By 1974, the Congress had charged that newly created agency with the responsibility for establishing national standards for air pollutants, drinking water contaminants, and water pollutants discharged by industries. Since 1974, federal decisionmaking responsibility has continued to expand. It now includes setting performance standards for treating and disposing of hazardous wastes, issuing regulations to reduce the risks from the production and use of commercial chemical substances, and evaluating the need for cleaning up abandoned hazardous waste sites.

In recent years, the Congress has considered returning some decisionmaking authority for protecting the environment to state or local governments. Its motive stems from a variety of factors, including a desire to reduce the size and reach of the federal government as well as a concern about the cost of environmental protection. One reflection of that interest is the recent Congressional action to address the growing number and cost of federal mandates with which state and local governments must comply.

The political process determines the level of government that makes decisions about environmental protection—or indeed any other public issue. The Constitution constrains the powers of the federal government over the states, but the distribution of power also reflects political forces that may favor centralized or decentralized government.

Economic analysis cannot prescribe which level of government should be making the various decisions about environmental protection. Economics does, however, help to answer the question of which level of government is most likely to make efficient choices about environmental protection—that is, choices that balance all of the relevant benefits and costs. “Environmental federalism” is a relatively new area of study in economics. Although it does not capture all of the forces that affect governmental behavior, it offers useful guidelines about how to allocate decisionmaking authority in a way that improves economic efficiency.

The Economic Theory of Environmental Federalism

The economist's perspective on federalism centers on the implications that alternative divisions of decisionmaking responsibility have on efficiency. The level of government most likely to make a decision that achieves maximum efficiency is the one with the most potential to make the nation, as a whole, better off. Economic principles suggest guidelines for allocating decisionmaking for the three aspects of environmental protection that this study examines:

- o Choosing the extent of environmental control or the level of an environmental standard;
- o Deciding on the methods of pollution control used to meet that standard; and

- o Determining and funding the basic research agenda for an environmental problem.

Choosing the Extent of Environmental Control

Which level of government might best determine the extent of environmental protection? If the objective is to maximize economic efficiency, then the primary issue to consider is whether the costs and benefits of efforts to protect the environment extend beyond local (or state) boundaries.

In general, when the answer to that question is no, economic principles indicate a stronger rationale for allowing localities (or states) to set their own standards. If the answer to that question is yes, a stronger rationale exists for setting standards at the regional or national level. However, as easy as that determination may seem to be, there are a number of wrinkles. For example, even when the answer to that question is clear, other factors may affect the efficiency of assigning the authority to set standards to different levels of government. Those factors include which level of government has the most information about underlying costs and benefits and whether centralizing the standard-setting process would yield savings in administrative costs. Furthermore, the objectives and capabilities of different levels of government will play an important role in that decision.

Another question economists have to consider in this regard is whether states or localities would be likely to choose less-than-optimal standards to attract industry to their area. Although that issue is potentially important, the evidence to support federally determined standards to avoid such a situation is not particularly compelling. Neither empirical nor theoretical models conclusively indicate that interjurisdictional competition results in less-than-optimal standards. A necessary, but not sufficient, condition for that to be true would occur if geographic differences in environmental regulations affected decisions about the location of industry. The evidence on whether such an effect occurs is inconclusive. However, even if it did take place, it would not necessarily mean that differences in environmental regulation reflected poor choices by lower levels of government. Theoretical models illustrate the possibility of either optimal or suboptimal results from com-

petition among jurisdictions. Finally, federally determined standards might not be efficient even if local standards that were likely to result in their absence were inadequate. Although federal regulations may make communities that would otherwise have inadequate standards better off, they may make others worse off—for example, communities for which the federal standard is higher than justified by the relevant costs and benefits.

Deciding on the Methods of Pollution Control

Lower levels of government are often likely to select more efficient methods of control. The opportunities for controlling pollution and the associated costs are, after all, likely to vary from one area to another. Lower levels of government often have superior knowledge of those variations and are therefore more able than the federal government to choose cost-effective methods of control.

Nevertheless, of particular importance are two potential exceptions to the primacy of lower levels of government in selecting efficient methods of control. One occurs when the options for control involve economies of scale in production. That feature can make it more cost-effective for multiple states to establish a control in a coordinated way rather than for individual states to establish varying controls on their own. Such a situation may arise when the method under consideration affects the design of a product sold in many jurisdictions.

A second possible exception may occur when selecting a method of control has effects outside the state. In that case, the state selecting the method of control does not have an incentive to consider the out-of-state effects associated with it. Both of those cases suggest that a more centralized level of government has a role in selecting efficient methods of control.

Finally, a third possible exception is when the federal government feels the need to intervene because states are unwilling—or unable—to choose efficient methods of control. In that case, the federal government may be in the best position to decide on the most efficient method.

Determining and Funding the Basic Research Agenda

When multiple states face the same type of environmental problem, economic principles indicate that the most efficient solution is to assign the responsibility for research to the federal government. The reason is simple: research results on the costs and benefits of environmental protection are essentially "public goods" that can simultaneously benefit multiple states. The federal government can provide them to additional states at very little cost. Decisionmakers should weigh the cost of conducting such research against the sum of benefits that all states would receive from the research.

Federal decisionmakers have an incentive to make that trade-off, but state decisionmakers do not. An individual state has an incentive to balance the cost of the research against its own expected benefits rather than the benefits that all states would receive. An individual state would therefore tend to underinvest in the research. Moreover, failure to share research results among states could result in an unnecessary duplication of effort. Furthermore, the federal government can use federal taxation to raise funds, thus ensuring that all potential beneficiaries will help pay for the research.

However, when the type of pollution in question has a limited geographic scope, assigning research responsibility to lower levels of government may be the most efficient approach. For example, if a pollution problem affects only a few states, the costs of negotiations to set and fund a research agenda will probably be low. In addition, those states may have greater access to, and more experience with, the problem than the federal government. Thus, they will have a better understanding of the research challenge and the main priorities. When a pollution problem affects only one jurisdiction, the case for that government to assume research responsibilities is even stronger. Negotiation costs then will not be a consideration.

Cooperative agreements among different levels of government to pursue and fund a comprehensive research agenda related to a given pollution problem are also effective. Such an approach can appropriately address the need for public goods with different groups of beneficiaries, while using cooperation to strengthen the effectiveness of the individual research efforts. In some cases, private industry may also become involved be-

cause of the potentially important influence of research results on industrial activity.

A Case Study of Protecting Drinking Water

This case study examines which level of government might most efficiently set standards, choose control methods, and manage research for protecting drinking water. The examination raises questions about whether the current federal role in setting standards is efficient. Local governments generally have an incentive to choose efficient drinking water standards. Federal selection of standards is likely to be efficient only if state or local governments would fail to choose standards that represented their constituents' best interests. The current allocation of authority for selecting control methods and research responsibility for drinking water is generally consistent with the principles of economic efficiency.

Choosing the Extent of Environmental Control

Most of the costs and health benefits from standards for drinking water are local. That factor suggests a rationale for allowing individual states, or even local communities, to choose their own drinking water standards. Given the general lack of effects that occur outside the community, standards that reflect the best interests of local residents will also reflect the best interests of the nation. Thus, local governments have a strong incentive to choose efficient standards for drinking water.

Considerations of information highlight the advantages of a decentralized approach to setting standards. The per-household cost of treating drinking water varies greatly among communities—particularly with differences in the size of water systems. Preferences for protecting drinking water also vary among communities. Local governments are therefore in the best position to choose drinking water standards that reflect those variations in costs and preferences.

The local nature of costs and benefits of treating drinking water and considerations of information pro-

vide a rationale for allowing local governments to set their own standards. However, the reality of the situation is otherwise: the federal government currently sets standards for drinking water protection. Those standards may impose welfare losses on communities compelled to undertake more treatment than their unique circumstances justify. Welfare losses represent the decrease in net benefits (benefits minus costs) that communities experience because of meeting federal standards.

Yet a look at other considerations may suggest advantages in having the federal government set standards. A primary consideration is whether state or local governments will choose—and put into place—efficient standards without federal requirements. If they do not, then the potential gains in efficiency from a decentralized approach to setting standards will not be realized. Hence, federal standards could be efficient if many state or local governments failed to choose efficient standards in the absence of federal requirements.

A second consideration stems from effects felt outside the local community. People outside a given community may want to ensure that the community's residents are provided a certain level of protection. For example, individuals may attach a value to knowing that all people living in the United States drink water that meets a certain standard of safety. When a given community chooses its standard, however, it does not have an incentive to take that value into account. If that value is very high, it may provide an economic justification for minimum federal standards. Those standards would provide uniform minimum protection for all individuals in the United States, but at the same time such standards would override local preferences.

This case study analyzes the welfare losses that might result from one standard currently proposed by the EPA. The proposed standard is for "adjusted gross alpha emitters," which are forms of radionuclides classified as human carcinogens. Annual welfare losses under the proposed standard range from \$38 to \$774 per household. Welfare losses are largest for households served by small drinking water systems, and they fall rapidly as the size of the system increases. That pattern stems from large economies of scale in treating drinking water. Economies of scale cause the per-household cost of treating drinking water to be much higher for small systems than for large systems. The

per-household benefit of treating drinking water, however, is not linked to the size of the system.

Large economies of scale are common to most—if not all—forms of drinking water treatment. Given those economies of scale, drinking water standards designed to balance the benefits and costs of treating drinking water for large systems can impose welfare losses on small systems. Such losses may occur under the Safe Drinking Water Act (SDWA). The 1996 amendments to that act allow the EPA, when setting standards, to consider the costs and benefits of large public drinking water systems as well as smaller systems unlikely to receive variances. However, large systems serve most of the population. As a result, the impact on large systems will dominate any overall analysis of costs and benefits. Standards that pass an overall cost-benefit test, therefore, may not be efficient for small systems. Nonetheless, careful consideration of costs and benefits should lower welfare losses incurred by large and medium-sized systems.

Welfare losses incurred by small systems would, of course, diminish if the EPA varied standards based on local circumstances. The 1996 amendments take a step in that direction. They do not direct the EPA to apply different standards to different water systems. They do, however, give the EPA the opportunity to let some small systems install treatment technologies that will not achieve federal standards. Those alternative technologies (called "variance technologies") must be both "affordable" and "protective of public health." Drinking water systems must receive approval to use variance technologies. Furthermore, the EPA and the states must overcome several hurdles before such technologies are widely used.

The analysis of adjusted gross alpha emitters does not account for the potential value individuals might place on ensuring that all U.S. residents drink water that meets the proposed standard. That analysis reveals, however, that the value attached to that external benefit would have to be extremely high to justify the proposed standard economically. The cost per cancer case avoided under the proposed standard is \$480 million for the smallest systems affected. The EPA uses cost per cancer case avoided as a unit for comparing the cost-effectiveness of various regulations. Because economies of scale in drinking water treatment contribute to that cost, many other drinking water standards

are likely to have very high costs per cancer case avoided for small systems as well.

The issue of whether local governments would choose adequate standards without federal requirements is not a critical one for the proposed standard for adjusted gross alpha emitters. That is because "no treatment" is the best course of action for nearly all systems—the costs of treatment being greater than the benefits for those systems. However, the issue of whether local governments would choose adequate standards is a critical one for other drinking water standards. Specifically, it will matter in cases in which more systems would receive positive net benefits under the standard in question. For those cases, it will probably be the primary consideration in determining whether federal standards are justified.

Deciding on the Methods of Pollution Control

Considerations of information also point to the advantages of allowing local water systems to determine their own method of meeting a given standard. In theory, water systems have considerable latitude in choosing treatment methods. The EPA does not require systems to use any particular technology for treatment to reach the standard. In reality, however, that latitude is actually limited because water systems must obtain state approval of the control technology they use.

In turn, states are frequently reluctant to approve the use of less-conventional technologies that may allow systems (particularly small systems) to meet the standard at a lower cost. The reluctance of states to approve those technologies has stemmed, in part, from concerns about their reliability, worries that the vendors providing them may not exist in the future to deal with problems that might arise, and doubts about the ability of systems to understand and operate the technologies effectively. Those concerns are valid. Nevertheless, general agreement exists that water systems would benefit from a streamlined process of approval and an increase in control options.

The 1996 amendments to the Safe Drinking Water Act include several provisions designed to give water

systems more latitude. The amendments require the EPA to list alternative technologies that different-sized systems might use, indicate the conditions under which they are effective, and update the list as new technologies become available. If successful, those changes should increase the variety of control options available to water systems.

Determining and Funding the Basic Research Agenda

The principles of economic efficiency highlight the importance of a strong federal role in assuming responsibility for research on drinking water. Assigning the responsibility for research to lower levels of government is likely to be efficient only when that research addresses problems with a limited geographic scope. Under certain circumstances, public/private cooperation in research efforts may be the most efficient approach. The actual division of responsibility for carrying out research on drinking water is generally consistent with principles of economic efficiency.

The federal government plays a key role in research on drinking water protection. The EPA has primary responsibility for assessing the effects on health from contaminants found in drinking water. It also sponsors efforts to develop and evaluate treatment technologies, particularly for small systems that typically face very high per capita treatment costs compared with large systems. Most states do not have significant research programs for drinking water. The primary exception is New Jersey, which sponsors research on issues specific to that state.

Finally, the federal government also provides funds to the American Water Works Association (AWWA)—an association of large, private drinking water facilities. The AWWA conducts research on the use of treatment techniques and management practices to reduce the presence of contaminants in drinking water. Those research results simultaneously help publicly and privately owned drinking water systems, as well as the EPA, to understand the costs of potential drinking water standards.

A Case Study of Controlling Ground-Level Ozone

This case study also examines which level of government sets standards, selects methods of control, and manages research for the control of ground-level ozone. In some instances, the division of responsibility among levels of government is consistent with principles of economic efficiency; in others, it is not. A fundamental problem in setting standards is that ozone and the emissions that cause it are transported across state borders. The uniform federal ozone standard that the EPA set under the direction of the Clean Air Act (CAA) does not adequately address the costs of interstate pollution.

As for selecting methods of control, the CAA contains federally required controls. In some cases, concerns about efficiency may justify the federal role. In others, however, federal involvement may unnecessarily conflict with the advantages of information that lower levels of government have in choosing methods of control. The division of responsibility for basic research on ozone corresponds best to the one suggested by principles of economic efficiency.

Choosing the Extent of Environmental Control

The most compelling argument for a centralized role in setting ozone standards stems from the growing evidence of the long-range movement, or "transport," of ozone pollutants. Given the transport of pollutants, individual states and localities that contribute to high concentrations of ozone in downwind areas lack the incentive to undertake sufficient levels of abatement. To obtain maximum efficiency, a central authority would need to set standards that balance the costs of reducing pollution in a given jurisdiction against the benefits. Those benefits would include any occurring outside the jurisdiction.

That balancing is unlikely to result in the same standard in all jurisdictions. Nevertheless, the current Clean Air Act instructs the federal government to set a uniform national ozone standard to protect human health with an adequate margin of safety. Those in-

structions may reflect the Congress's assessment of the value that the nation—as a whole—places on having all U.S. residents breathe air that meets a certain standard of safety. If that value is sufficiently high, it can provide an economic justification for a minimum federal standard.

Even in that context, however, the basic approach of the CAA does not capitalize on the federal government's potential to allocate abatement efforts in a way that accounts for interstate effects. The CAA's basic framework increases the stringency of an area's abatement requirements according to the severity with which it violates the standard. To date, provisions in the CAA that would require areas to account for the downwind effects of the pollution they generate have not been fully used. As a result, achieving the national standard may be unnecessarily costly. Further analysis is, of course, vital. But this study demonstrates potentially substantial cost savings from considering the long-range transport of ozone pollutants in determining an area's required level of abatement.

Economists typically view the federal government as the appropriate authority for setting standards when pollution crosses state borders. However, some analysts have considered the possibility of setting standards through multistate regional authorities or through negotiated agreements among states. Those alternatives may allow states to address problems linked to the transport of pollutants while capitalizing on their potential strengths over those of the federal government. Such strengths include better information on unique factors affecting abatement costs and the value their communities attach to having clean air.

The federal government has taken two important steps toward regional decisionmaking to address the problem of transported ozone pollutants. First, the CAA established an Ozone Transport Commission (OTC). That authority's jurisdiction includes all, or part, of 12 northeastern states plus the District of Columbia. Substantial evidence indicates movement of ozone pollutants within that region. The commission has the authority to make recommendations to the EPA on strategies to address violations of the standard within the region. Once the EPA approves those recommendations, all affected states within the region must undertake corresponding controls.

Second, a 1995 EPA policy initiative led to the formation of the Ozone Transport Assessment Group (OTAG). The OTAG was a national workgroup formed in partnership by the EPA, the Environmental Council of States, and various industry and environmental groups. It negotiated agreements addressing the problem of long-range transport of air pollution across the 38 easternmost states. The OTAG concluded its negotiations and offered recommendations to the EPA in June 1997.

Both the OTC and the OTAG offer a method of addressing the problem of the transport of ozone pollutants while recognizing differences in abatement costs among localities. They therefore have the potential to decrease the overall cost of achieving the ozone standard. Both, however, have faced significant challenges. The primary limitation of the OTC is that the geographic area over which it has authority does not cover the full range of the transport of ozone pollutants. Although the OTAG covered a larger geographic area, its primary drawback was its lack of authority. The OTAG had no decisionmaking authority under federal law; it relied instead on the consensus and cooperation of member states to achieve solutions. But achieving consensus within the OTAG on specific recommendations was formidable because of the wide distribution among member states of the costs and benefits from potential solutions. More specifically, states outside the Northeast receive relatively few benefits compared with the costs they are likely to incur, whereas northeastern states have more to gain from cooperation.

The EPA used the modeling conducted by the OTAG as a basis for proposing reductions in emissions for 22 states thought to be contributing to nonattainment problems in downwind states. The ultimate success of the OTAG process will depend, in part, on the extent to which its existence facilitates the finalization and effective implementation of those reductions.

Deciding on the Methods of Pollution Control

Considerations of information point to the advantages of allowing states to determine their own method of meeting a given ozone standard. But that general rule has some potential exceptions to it. For example, if controls have economies of scale in production or affect

jurisdictions outside the state, a federal role might be justified on the grounds of efficiency.

States use a combination of federally prescribed control methods and methods of their own choosing in meeting the ozone standard. The division of responsibility in choosing methods of control does not always correspond to principles of efficiency. In some cases, federal requirements reduce the flexibility that the Clean Air Act appears to grant to states in selecting methods of control.

Many federally prescribed controls do not exhibit characteristics—such as economies of scale in production or interstate effects—that imply a need for federal involvement on efficiency grounds. A potential exception is the federal government's prescribed control on tailpipe emissions from motor vehicles. Given economies of scale in production in the automobile industry, manufacturers would find it costly to comply with many varying state standards for tailpipes.

More generally, the active federal role in defining control methods for ozone may stem, in part, from the Congress's frustration with the states' objectives and capabilities. If states do not try to improve their constituents' welfare—or are incapable of carrying out control programs that do so—federal involvement may be justified on the grounds of efficiency. The Congress, for example, mandated requirements for the vehicle inspection and maintenance (I/M) program that became increasingly specific over time. Advocates of that strong federal role argue that I/M is a cost-effective means of reducing ozone and that states have not adequately exploited those opportunities.

The counterargument is that states do aim to improve the welfare of their constituents and can carry out appropriate programs. According to that view, states have been justifiably reluctant to establish the federal I/M program because those program requirements may not be cost-effective for every state.

This study examines the validity of arguments supporting those two opposing views. Ultimately, however, the information needed for a thorough assessment of those arguments is not available. Thus, one cannot definitively determine whether states' objectives and capabilities hinder or aid the adoption of efficient methods of control.

Determining and Funding the Basic Research Agenda

The breakdown of responsibility for research on ground-level ozone is generally consistent with the principles of efficiency. The federal government has the primary responsibility for that research. The Environmental Protection Agency is the main supporter of research on the health and ecological effects of ozone. In addition, the federal government has been the primary sponsor of research to develop air-quality models. Analysts use those models to examine the relationship between ambient ozone concentrations and factors such as topography, meteorology, and emissions of pollutants.

Lower levels of government also assume research responsibility for problems unique to their jurisdiction. For instance, different states have built on federal modeling efforts to understand more thoroughly their unique ozone problems. The state of California, which attaches a relatively high priority to addressing ozone pollution, has supplemented federal research on both exploring health effects and developing models.

Finally, the North American Research Strategy for Tropospheric Ozone is a cooperative agreement between national and state governments and the private sector. Such a framework can address the need for public goods that benefit different jurisdictional levels—international, national, or state. It also feeds decision-makers more information by involving private concerns in a process with potentially important effects on industrial activity.

Conclusions

Using a perspective of economic efficiency, this analysis led to a number of findings.

- o Selecting the level of government most appropriate for determining optimal standards involves several considerations. First, one must take externalities into account. Those are costs or benefits that extend beyond jurisdictional boundaries. Furthermore, local variations occur in both abatement costs and the relative value that citizens place on

the benefits of environmental protection. For drinking water, the local nature of environmental consequences and the variation by locale in abatement costs favor decentralized standard setting to achieve efficiency. However, federally determined drinking water standards may be efficient if lower levels of government are unwilling, or unable, to choose standards that reflect their constituents' best interests. In contrast, for ground-level ozone, interstate movement of ozone pollutants favors centralizing the setting of standards—a process that should be sensitive to the local variation in abatement costs and the preferences of citizens.

- o Selecting efficient control methods requires detailed knowledge of the opportunities for pollution control and their associated costs. For both drinking water and ground-level ozone, that need for knowledge points to a predominant decisionmaking role for decentralized levels of government. One potential exception is if the per-unit cost of the control is lower when it is widely used. In that case, federal standards may be more efficient than varying state standards. Vehicle tailpipe controls designed to reduce ozone levels exhibit such economies of scale in production.
- o Economic efficiency in determining and funding research on both protecting drinking water and controlling ground-level ozone points to a predominantly federal role. The reason is simple: research that the federal government manages can benefit multiple states simultaneously.

One must weigh a variety of considerations when deciding which level of government is most likely to make decisions that result in maximum efficiency for three different aspects of environmental protection: choosing the extent of environmental control, deciding on the methods of control, and determining and funding the basic research agenda. Those considerations include interstate effects, the advantages of information that various levels of government possess, potential economies of scale in control measures, and government objectives and capabilities. A sound understanding of those considerations is key in selecting the allocation of responsibility for environmental protection that is most likely to achieve economic efficiency. The case studies of drinking water and ground-level ozone show how those considerations might be applied.

Economic Theory of Environmental Federalism

In recent years, the Congress has considered increasing the authority of states to carry out federal environmental statutes. Some bills considered in the 104th Congress, for example, would have increased the role of the states in administering and enforcing cleanup at Superfund sites as well as listing endangered species. Other bills would have allowed states to develop management plans for industries and firms that discharge polluted storm water rather than requiring federal permits. Although reallocating responsibility may be beneficial in some cases, it may fall flat in other cases. Careful analysis can highlight the considerations that policymakers will want to take into account in making those decisions.

The interest in reconsidering the roles of different levels of government in environmental protection stems from a variety of sources. Some policymakers want to decrease the size and reach of the federal government. Furthermore, the growing cost of environmental protection has sparked an interest in revising programs to lead to more cost-effective solutions. Finally, protests about unfunded mandates highlight the growing number—and cost—of federal regulations with which states must comply. During that debate, participants frequently point to environmental mandates.¹

The economist's theory of federalism focuses on how alternative divisions of responsibility can spark increased efficiency. Specifically, that viewpoint tries to provide maximum incentives for various levels of government to make decisions that will balance all the relevant costs and benefits of environmental protection. That perspective differs from the political scientist's perspective, which typically focuses on the constitutional division of power. Economists usually characterize centralized decisions—or ones made by the federal government—as uniform. Thus, the same standard is applied to all states or localities. Economists typically contrast those centralized decisions with decentralized decisions that reflect underlying differences among states or localities. Under that approach, one must choose between uniform centralized solutions or varied decentralized solutions.

This study takes a broader perspective of the alternatives.² It examines the possibility of centralized solutions that reflect differences among areas—for example, federally determined standards that would vary based on local characteristics. It also looks at decentralized solutions that reflect cooperation among areas—for example, negotiated agreements among states to address interstate pollution. That perspective allows a broader

1. The U.S. Conference of Mayors and the National Association of Counties collected information about specific mandates to draw attention to the mandates issue. Nine of the 11 mandates addressed by the U.S. Conference of Mayors were environmental ones. Seven of the 12 mandates addressed by the National Association of Counties were also environmental ones. See U.S. Conference of Mayors, *Impact of Unfunded Federal Mandates on U.S. Cities* (Washington D.C.: U.S. Conference of Mayors, October 1993); and National Association of

Counties, *The Burden of Unfunded Mandates: A Survey of the Impact of Unfunded Mandates on American Counties* (Washington D.C.: National Association of Counties, October 1993).

2. For previous work by the Congressional Budget Office on this topic, see *Environmental Federalism: Allocating Responsibility for Environmental Protection*, CBO Staff Working Paper (September 1988).

discussion of possibilities for improving efficiency. In addition, it more accurately reflects the actual options available.

In this study, two case studies—the protection of drinking water and the control of ground-level ozone—apply the concept of environmental federalism. Protecting drinking water makes an interesting case study because most of the costs and health benefits of treating drinking water fall on the local population, thereby suggesting a rationale for decentralizing the selection of standards for drinking water. However, the federal government now determines those standards. Whether federal standards are needed to ensure economic efficiency depends on several considerations. One is whether, without federal regulations, state or local governments would have sufficient motivation and resources to choose and put in place standards that reflected their community's priorities and the costs of treating drinking water. A second is how great a value the nation attaches to ensuring that all citizens have access to drinking water that meets a given standard.

The control of ground-level ozone also makes an intriguing case study. First, unlike the problem of treating drinking water, the problem of ground-level ozone involves interstate pollution. Moreover, although the process of setting standards for ozone is currently centralized, for the most part that process does not address the interstate problem of ozone. Finally, the federal government has directed states to form regional groups to address the problem of the interstate movement, or "transport," of ozone pollutants. Forming regional groups represents a relatively new approach for dealing with pollution problems.

Defining Economic Efficiency

What does "economic efficiency" actually mean? Several alternative concepts are in play. According to the concept used in this study, economic efficiency is achieved when society uses resources in a way that yields the highest value of the goods and services it produces. This study's definition of "society" is all of the residents of the United States. The concept of goods and services includes leisure and environmental services, such as clean air and water. The welfare of the

nation as a whole will be greatest if efficient decisions are made about protecting the environment.

Policies designed to protect the environment impose impressive costs—consider, for example, the cost of installing equipment for pollution abatement. Such policies also create benefits, such as improved health and recreational opportunities. A policy improves efficiency if those who benefit can fully compensate for the losses in welfare (that is, the losses in well-being) of those who bear the cost of the policy. This study does not attempt to answer the question of whether those who benefit should pay compensation. Although that question is important, it is different from the question of whether a policy has the potential to make every member of society better off. Related to the issue of whether compensation should be provided is the question of which level of government can most appropriately finance environmental protection (see Box 1).

This study uses principles from the economist's perspective on federalism to offer guidance in assigning responsibilities for environmental protection to different levels of government. Specifically, the study analyzes which level of government—local, state, regional, or federal—is most likely to make decisions that achieve economic efficiency in three areas of environmental protection:

- o Choosing the extent of environmental control or the level of an environmental standard;
 - o Deciding on the methods of pollution control used to meet that standard; and
 - o Determining and funding the basic research agenda for an environmental problem.
-

Choosing the Extent of Environmental Control

Which level of government will choose the most efficient level of environmental protection? That question is also one that economists have written about most. The answer seems simple—the level of government that has the incentive and the knowledge to choose the most

efficient level of protection. In reality, however, determining the efficient level of protection and evaluating the incentives and knowledge of various levels of government can be difficult tasks.

Protecting the environment both creates benefits and imposes costs. With more stringent environmental standards, both costs and benefits increase. The efficient level of protection, or the optimal standard, is the level that will bring the most "net benefits" to society—that is, the benefits society receives minus the costs that it incurs. Choosing a level of protection—or an environmental standard—that is either too high or too low compared with the efficient level may make society worse off.

Five different considerations may affect the decision about which level of government is likely to choose the most efficient degree of environmental protection. Those considerations are listed with an indication of which level of government is apt to set efficient standards when all other factors are equal.

- o *Externalities.* Do the costs and benefits of environmental protection extend beyond the jurisdic-

tional boundaries of a state or local government? If so, that government will not have an incentive to choose the efficient level of protection. Thus, the presence of externalities highlights the advantages of centralized standard setting.

- o *Information.* Which level of government has the most information about the costs and benefits of reducing pollution? In general, the federal government has better information about the basic health and environmental effects of pollution, and lower levels of government have better information about unique factors affecting their costs and benefits. Because the federal government can send the same basic information to each community, doing so is less costly than transferring information about each specific locale to the federal government. Thus, on the basis of the most pertinent information and the cost of transferring it, lower levels of government have the advantage in choosing standards.
- o *The Costs of Decisionmaking.* Does choosing a standard entail large decisionmaking costs? If so, centralized determination of a standard that applies to many lower levels of government might reduce

Box 1.

Financing Environmental Improvements

In some instances, governments may want to finance pollution control. For example, governments may want to defray the large costs per household that can occur in small communities for some types of pollution abatement, such as wastewater treatment. However, several considerations arise when governments become involved in financing environmental improvements, including distributional issues as well as how financing might affect decisions about environmental protection programs.

The federal government raises funds primarily through personal income taxes, payroll taxes, and corporate income taxes. State governments primarily use personal and corporate income taxes and may also make substantial use of sales taxes. In contrast, local governments generally raise funds through property taxes and user fees. Those different methods of financing have varying implications for ultimately distributing the financial burden of environmental protection. Thus, the level of government that provides financing can in-

fluence, among other things, the proportional burden on individuals based on their income level as well as their location.

Regardless of which level of government is financing environmental protection, if funding programs are not carefully designed, they can create undesirable incentives for decisionmakers. For example, the availability of federal funds could cause state or local governments to delay abating pollution in order to receive federal dollars. In addition, providing funds could affect the type of pollution-abatement project that is undertaken.

Whether governments should provide financing and which level of government can most appropriately do so are important questions. A comprehensive discussion of financing, however, is beyond the scope of this study. Provided that the manner of financing does not distort the choices for decisionmakers, one can view financing questions as independent from the issues of efficiency that this study addresses.

those costs. The costs of decisionmaking therefore highlight the advantages of centralized standard setting.

- o *Interjurisdictional Competition.* Will lack of federal standards lead lower levels of government to engage in competition to attract industry, and will that in turn lead to standards that are less than optimal? The potential for destructive interjurisdictional competition illuminates the advantages of centralized standard setting.
- o *Government Objectives and Capabilities.* Are all levels of government trying to achieve the maximum welfare of their constituents? Do all governments have the resources and expertise to carry out the standard they choose? This study does not attempt to determine which level of government is most likely to have the objective of maximizing the welfare of its constituents. Further, this study is not able to draw general conclusions about government capabilities. Hence, it does not indicate which level of government is most likely to set efficient standards based on its objectives or capabilities. The study does, however, discuss how those considerations can be relevant when assigning authority to set standards.

When examined in isolation, some of the considerations point to the advantages of more centralized decisionmaking. Other considerations illuminate the advantages of more decentralized decisionmaking (see Table 1). Policymakers will want to take all factors into account. Nevertheless, not all are equally important in choosing which level of government is most likely to pick environmental standards that achieve maximum net benefits for society. The presence of externalities is the primary consideration. When all other factors are equal, decentralized standard setting will be more efficient when externalities are not present. Centralized standard setting is usually more efficient when externalities are present. The other considerations listed above, however, may result in important exceptions to that general rule.

Policymakers have the option of assigning decisionmaking responsibilities to different levels of government—local, state, regional, and federal. For a clear exposition of the pros and cons of centralized versus

decentralized standard setting, the following discussion focuses on the two extremes—local versus federal.

Externalities

The key consideration in determining which level of government has an incentive to choose an efficient standard is whether the costs and benefits from that standard extend beyond local boundaries. In short, do significant externalities exist? In general, when significant externalities do not exist, the rationale for allowing local governments to set their own standards is stronger.

Table 1.
Considerations Indicating Whether Centralized or Decentralized Decisionmaking Is Likely to Be More Efficient

Considerations	Standard Setting	Control Selection
Externalities Present ^a	Centralized	Centralized
Information Advantages ^b	Decentralized	Decentralized
High Decision-making Costs	Centralized	Centralized
Destructive Interjurisdiction Competition Likely	Centralized	c
Economies of Scale in Production	c	Centralized
Government Objectives and Capabilities	d	d

SOURCE: Congressional Budget Office.

a. Primary consideration for standard setting.

b. Primary consideration for selecting method of control.

c. Not a primary consideration for this aspect of environmental decisionmaking.

d. Neither centralized nor decentralized decisionmaking has a clear advantage in this case.

Conversely, when significant externalities do exist, the rationale for setting standards at the federal level is stronger.

When Externalities Are Relatively Small. Most of the decisions that a locality makes have some effect on individuals outside its borders. In some cases, however, those externalities are much smaller than the effects of those decisions on the locality's own residents. For example, consider a decision about the amount of space a community will devote to neighborhood parks. That decision could affect nonresidents; after all, people from nearby communities may use the parks. However, the community's residents shoulder most of the costs of the decision (higher property taxes, for example) and most of the benefits (more recreational space). In that case, because the externalities are relatively small, maximizing the net benefits to the community's residents is consistent with maximizing the net benefits to society.

Economic principles pinpoint two advantages of making decisions at the local level when the costs and benefits fall mainly on local residents. First, local decisions best reflect the unique factors affecting costs and benefits within different jurisdictions. Second, the resulting diversity in environmental protection may allow individuals to live in communities that best suit their preferences.

The costs and benefits of environmental standards vary among communities. Costs may vary based on many factors including topography, weather conditions, and the composition of local industry. Benefits may differ based on factors such as the size and demographic characteristics of the local population. Localities with larger populations, for example, might avoid more adverse health effects by a given improvement in air quality than would localities with smaller populations. Furthermore, benefits reflect not only the physical effects of a standard—for example, cancer cases avoided—but also the value that the community attaches to those effects. Benefits, therefore, reflect specific preferences of the community.

When federal officials set standards, they find it difficult to obtain all of the relevant information on the costs to and benefits for a specific community. As a result, standards set at the federal level tend to be more uniform than appropriate. They tend to be too high for

some communities and too low for others. The greater the underlying differences in costs and benefits among different communities, the greater are the potential welfare losses from the federal government's setting a uniform standard. Of course, potential welfare losses diminish if the federal government can set standards that vary with local conditions.

Most standards specify a minimum level of environmental protection, not a maximum. Consequently, the losses in welfare from centralizing standard setting occur in communities that are forced to have higher standards than they would otherwise choose. Those losses in welfare indicate the extent to which communities are worse off because they must comply with federal standards that do not reflect their unique circumstances. Welfare losses are measured as the decrease in net benefits that a community experiences when it meets an environmental standard that is not optimal for its unique circumstances.

The second advantage of local decisionmaking is the diversity in environmental standards that results among communities. That diversity may enable individuals to live in communities that best reflect their own preferences.³ For example, individuals valuing clean water may choose communities that have stringent standards for water quality, although people obviously will face certain limits when making such choices.

When Externalities Are Relatively Large. The case for federal standard setting is much stronger when a significant share of the costs or benefits of a community's decision falls outside its borders. In those cases, local standards are not likely to be efficient, since the local government will not have an incentive to take into account the benefits (or costs) that fall outside its jurisdiction. For example, a community is not likely to consider fully the benefits that downstream communities receive when it reduces the pollution it releases into a stream. Instead, the community accounts only for its own benefits and therefore does not reduce the pollution enough to maximize the net benefits to society (which include downstream benefits).

To select the efficient extent of control, an authority that encompasses all affected communities must

3. Charles M. Tiebout, "A Pure Theory of Local Expenditures," *Journal of Political Economy*, vol. 64, no. 4 (August 1956), pp. 416-424.

often make the decisions on setting standards. Depending on the pollutant involved, that may be a county government, a state government, a multistate regional organization, the national government, or even an international organization. Many types of air and water pollutants are likely to travel across local boundaries, indicating a role for a centralized level of government in setting standards.

Nonetheless, standards set by a central authority need not be uniform. Because costs and benefits, including externalities, are apt to vary from area to area, the optimal level of the standard will similarly vary. However, constraints on information may make it difficult for the federal government to set standards that fully reflect that variation.

So far, this discussion has focused on relatively contemporary physical externalities. However, externalities may take on another form when the benefits of current efforts to reduce pollution spill over to future generations. In such cases, local community decisions may undervalue protecting future generations, if only because, given population mobility, local officials may not determine the environmental heritage of their community's own descendants. However, local communities will be less likely to undervalue the environmental benefits that accrue to future residents if the property values of current residents reflect those benefits. Local governments will then have an economic incentive to incorporate the benefits to future generations into their decisionmaking.⁴

Externalities can also take a third form—referred to here as a "safety-concern" externality.⁵ That form of externality occurs when nonresidents of Community X value knowing that X's residents receive at least a minimum level of environmental protection. For example,

nonresidents of Community X may value knowing that residents of Community X breathe air that meets certain minimum health standards. Community X residents will not consider that value and may choose a lower standard than is optimal from a national perspective. If that value is sufficiently high and is applied to all communities, it may provide a justification for minimum federal standards. That is, requiring all communities to meet a minimum federal standard—regardless of their own preferences—might improve national social welfare. The safety-concern externality may manifest itself as concern about providing uniform protection for all individuals or as a reference to environmental protection as a "basic right."⁶

The safety-concern externality reflects a paternalistic concern. Nonresidents care about the safety of Community X's residents even though the residents themselves may place a higher value on other amenities. If nonresidents cared about a more general measure of the welfare of Community X's residents—a measure that also reflected the residents' preferences—then federal intervention would not be efficient. In that case, national welfare would reach a maximum level when Community X chose the standard that reflected its own preferences. That discussion assumes, of course, that residents have sufficient information on the costs and benefits of pollution to have informed preferences on environmental standards.

Information

Decisions about environmental standards are most likely to be efficient when they are based on accurate information about the costs and benefits of environmental protection. An important consideration therefore is the level of government that has the best information about those factors.

4. Wallace E. Oates, "Economics, Economists, and Environmental Policy," *Eastern Economic Journal*, vol. 16, no. 4 (October/December 1990), pp. 289-296.

5. This externality stems from a form of altruism referred to as safety-based altruism. Safety-based altruism means that individual *i* attaches a value to *j*'s safety—regardless of *j*'s own preferences. Given that form of altruism, it is best to provide *j* with more safety than *j* would choose on his or her own. That is, providing *j* with more safety than *j* would choose will improve national social welfare. If, however, individual *i* is concerned with the overall welfare of individual *j* and not just *j*'s safety (referred to as pure altruism), then it will not be best to provide *j* with more safety than *j* would choose. See M.W. Jones-Lee, "Paternalistic Altruism and the Value of Statistical Life," *Economic Journal*, vol. 102 (January 1992), pp. 80-90.

6. Policymakers often allude to this type of externality when establishing minimum federal standards for environmental protection. For example, during 1973 hearings on the Safe Drinking Water Act, the Deputy Administrator of the Environmental Protection Agency commented, "We believe that the establishment of these primary standards should be a Federal responsibility of the Environmental Protection Agency. Standards for health protection do not vary with locality." Statement of Robert W. Fri, Deputy Administrator, Environmental Protection Agency, before the Subcommittee on Public Health and Environment of the House Committee on Interstate and Foreign Commerce, March 8, 1973.

In general, the federal government has better information about the relationship between alternative levels of a standard and individual or environmental risk. For example, the federal government typically has better information about the risk of cancer from exposure to a given level of air pollution than do other levels of government. Similarly, the federal government has better information than other levels of government about the average risk of fish dying when they are exposed to a given level of water pollution. Local governments, in turn, have greater knowledge of the factors that are specific to their locales, including:

- o Factors affecting the physical benefits to a community of meeting a given standard—for example, demographic characteristics (such as the number of elderly, a population particularly susceptible to ill effects from air pollution) or the type of fish in local bodies of water;
- o Local preferences; and
- o Factors affecting the costs to a community of meeting a given standard—for example, local labor rates and the cost of raising capital by issuing bonds.

If transferring information between levels of government was costless, then it would not matter which level had better information about costs and benefits. Transferring information, however, is not without cost. Because the federal government can send the same basic information to each community, transferring such general information about risks is less costly than transferring information that is specific to each locality. Thus, if all other factors are equal, information and the cost of transferring it favor assigning standard setting to lower levels of government. The advantages of information are the reason why decentralized standard setting is likely to be most efficient when both costs and benefits are local.

Information on how the preferences for environmental protection may vary among communities is an advantage that local officials possess. Citizens can be expected to have sound preferences, however, only if they are informed about the costs and benefits of environmental protection. That task may be particularly important when environmental risks are not visible,

such as odorless air or water pollutants. In some cases, the federal government may wish to ensure that citizens are well informed even if the authority for standard setting is assigned to lower levels of government.

When externalities are large, considerations about information highlight an important trade-off. Setting standards at the federal level may be more effective for dealing with externalities. Constraints on information, however, may make it difficult for the federal government to set standards that reflect all of the variation in costs and benefits among areas.

Thus, the presence of externalities does not necessarily mean that the federal government will set more efficient standards than local governments. Whether society will be better off with federal standards depends on the gains in welfare from taking externalities into account, and on the losses in welfare from failing to vary standards appropriately among areas. Federal standards are likely to be more efficient than local standards when externalities are large and when federal standards take into account the differences in costs and benefits among areas.

Not all cases involving externalities call for the federal government to set standards. Regional authorities that have jurisdiction over the area affected by a pollutant may also set standards that account for externalities. Those authorities may have advantages in choosing efficient standards because of their knowledge of costs and benefits specific to their region. However, policymakers will also want to consider the administrative costs of establishing and operating those regional authorities. Any decision about the level of centralization that might be appropriate must balance those two concerns.

Another method of dealing with externalities could also capitalize on the advantages of local information that lower levels of government have. Affected parties, such as states, might negotiate an agreement on the environmental standard. In some cases, negotiated solutions may be advantageous, since the federal government has limited knowledge of the differences in preferences that citizens have from state to state. The federal government may also face political pressure to set uni-

form standards for states.⁷ Although lower levels of government may be able to negotiate solutions, the transaction costs—or the costs of those negotiations—may be very high.⁸ In general, negotiated solutions are more feasible when the number of affected parties is small.

The Costs of Decisionmaking

Choosing an environmental standard requires evaluating information about its costs and benefits compared with other standards that might be selected. Making that choice will require government resources. The cost to society of making decisions on setting standards tends to be less when the federal government makes decisions instead of lower levels of government. The federal government typically chooses a uniform national standard, or a few standards that it applies as most appropriate throughout the United States. Therefore, when all other factors are equal, considerations about the costs of decisionmaking will lead to more centralized standard setting.

Nevertheless, the federal government—or the private sector—could lower the costs of local decisionmaking by putting technical information into a form that would be more useful to local decisionmakers. For example, it might provide guidelines—or suggested standards appropriate under average conditions—that would reflect scientific information. Local governments could then choose the actual level of the standard based on their unique circumstances.

Interjurisdictional Competition

State or local governments may compete to attract businesses by lowering environmental standards to reduce the costs of controlling pollution. Such competition may benefit society. Communities would be better off

if the benefits that they received from more local business investment outweighed the costs that they incurred from lower levels of environmental protection. Those benefits might include more jobs, higher wages, and an expanded tax base.

Alternatively, competition might make communities worse off if local decisionmakers were to lower standards to the point at which the costs of less environmental protection outweighed the benefits of increased business investment. Some people argue that minimum federal environmental standards are necessary to prevent such destructive interjurisdictional competition.⁹

The potential for destructive interjurisdictional competition has raised significant concern. Yet determining if that concern is justified is difficult. No empirical evidence exists on whether governments have chosen less-than-optimal levels of environmental protection to bring more industry to their areas. Furthermore, theoretical models in the economic literature are inconclusive on the issue. Some researchers have demonstrated conditions under which interjurisdictional competition causes local officials to choose efficient standards. However, the extent to which those conditions reflect the real world is uncertain.¹⁰

Several studies have examined a necessary—but not sufficient—condition for destructive interjurisdictional competition to occur. Those studies tried to determine the extent to which geographic differences in environmental regulations actually affected decisions about the location of industry. Unfortunately, the evidence that those studies provide is inconclusive.¹¹

7. Perry Shapiro, "Which Level of Government Should Be Responsible for Environmental Regulation: The Federalists Versus Calhoun," in John B. Braden, Henk Folmer, and Thomas S. Edwards, eds., *Environmental Policy with Political and Economic Integration: The European Union and the United States* (Brookfield, Vt.: Edward Elgar Publishing, 1996), p. 140.

8. William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy* (New York: Cambridge University Press, 1988), pp. 9-13.

9. John H. Cumberland, "Efficiency and Equity in Interregional Environmental Management," *Review of Regional Studies*, vol. 2, no. 1 (1981), pp. 1-9.

10. Wallace E. Oates and Robert M. Schwab, "Economic Competition Among Jurisdictions: Efficiency Enhancing or Distortion Inducing?" *Journal of Public Economics*, vol. 35, no. 3 (1988), pp. 333-354; Wallace E. Oates, *The Invisible Hand in the Public Sector: Interjurisdictional Competition in Theory and Practice*, Working Paper No. 95-17 (College Park, Md.: University of Maryland, Department of Economics, 1996). Game theoretic models that allow for strategic interaction between governments illustrate that both optimal and suboptimal outcomes are possible.

11. For examples of these analyses, see Timothy J. Bartik, "The Effects of Environmental Regulation on Business Location in the United States," *Growth and Change*, vol. 19 (Summer 1988), pp. 23-45; Vernon Henderson, "Effects of Air Quality Regulation," *American Economic Review*, vol. 86, no. 4 (September 1996), pp. 789-813; and Virginia

Yet even with destructive interjurisdictional competition at local levels, federally determined standards may not be more efficient. Because the optimal trade-off between new industry and more stringent environmental standards will vary with local circumstances, the uniformity that often characterizes federal standards would impose welfare losses on some communities. Hence, one needs to consider whether welfare losses from federal standards would be more or less than those from various imperfect local standards.

Finally, even a uniform national standard does not eliminate the incentive of industries to locate in areas where control costs are lower. Areas with higher initial levels of pollution will have to impose higher control costs on industries to meet that standard. Setting standards at the federal level, however, does curtail the ability of lower levels of government to use lax environmental standards as a means of competing for new business.

Government Objectives and Capabilities

Government officials are most likely to choose efficient standards if they want to achieve maximum welfare for their constituents. If they have other objectives in mind, such officials may not make efficient decisions. Instead, their goal might be to increase their budgets or to appease special interests within their jurisdictions.¹²

First, consider a case in which externalities are relatively small. Decentralized standard setting would seem to be efficient since it would enable local officials to choose standards that reflect their unique circumstances. But what if local officials did not aim to choose standards that attain maximum welfare for their constituents? In that case, federal standards might be more efficient. Whether they are depends on two fac-

tors: the size of the gains in welfare that federal standards bring to communities whose governments do not attempt to maximize their constituents' welfare, and the size of the welfare losses that federal standards impose on communities forced to comply with higher standards than their unique circumstances justify.

Next, examine a case in which externalities are relatively large. Those externalities provide a rationale for centralized standard setting. If local governments do not seek to choose standards that provide maximum welfare for their constituents, then the case for federal standards will be even stronger.

If a government chooses an efficient standard but does not have the resources and technical expertise needed to achieve it, then society will not realize the potential gains in welfare from that standard. The outcome would be the same as if the government had not chosen an appropriate standard.

If one level of government wants to choose an efficient standard but cannot enforce it, those two responsibilities might be separated. That is, one level of government might choose the standard, while another designs and carries out the program to achieve that standard. For example, for environmental problems without large externalities, local governments might choose standards based on their superior knowledge of unique circumstances affecting costs and benefits. However, state governments or the federal government might enforce those standards in some—or all—localities. Similarly, the federal government might choose environmental standards in some circumstances, and state or local governments would enforce them.

Identifying the level of government best suited to enforcement is an important aspect of environmental federalism. Enforcement usually includes a range of activities such as self-reporting, monitoring, inspecting, negotiating to develop compliance plans, and civil or criminal penalties. The appropriate level of government for taking on enforcement responsibilities depends on several factors. They include the geographic characteristics of the pollution problem, as well as the information, enforcement tools, and resources available to different levels of government. Several different levels of government might share responsibility for enforcement. In some cases, the federal government would provide backup authority for lower levels of gov-

D. McConnell and Robert M. Schwab, "The Impact of Environmental Regulation on Industry Location Decisions: The Motor Vehicle Industry," *Land Economics*, vol. 66, no. 1 (February 1990), pp. 67-81.

12. Some analysts argue that bureaucrats seek to increase their budgets rather than further the interests of their constituents. See William Niskanen Jr., *Bureaucracy and Representative Government* (Chicago: Aldine Publishing, 1977), pp. 38-41. Wallace E. Oates and Robert M. Schwab demonstrate that budget-maximizing governments will not have an incentive to choose socially optimal levels of environmental protection. See Oates and Schwab, "Economic Competition Among Jurisdictions," pp. 343-345.

ernment. Although enforcement is an important consideration, a more detailed discussion of the issue is beyond the scope of this study.¹³

The issue of government objectives is crucial in determining which level of government is most likely to choose efficient standards. Another key consideration is the ability of governments to carry out programs effectively to achieve selected standards. However, making generalizations about the objectives or abilities of different levels of government is difficult.

Concern about the objectives and abilities of states was one factor that led to the strong federal role in environmental protection. Twenty-five years ago, "states were widely derided as mired in corruption, hostile to innovation, and unable to take a serious role in environmental policy out of fear of alienating key economic constituencies."¹⁴ Those concerns were not limited to environmental issues. Federal growth in other areas—such as education and health services—during the 1970s is attributed, in part, to poor performance by state and local governments. According to Alice Rivlin, "states and their local governments were seen as lacking the means and capability to provide services in a modern society."¹⁵

The general capability of state governments has, however, markedly improved since the 1960s. Reasons cited for that change include the strengthened ability of governors to provide state leadership, substantial increases in the size and professional qualifications of state staffs, legislative reforms, increased party compe-

tition at the state level, and better state revenue-raising systems.¹⁶

Moreover, environmental policy is sometimes cited as an area in which states' effectiveness has improved. In fact, several states have taken the lead in environmental policy. Those states have exceeded federal requirements and developed innovative approaches to deal with pollution. Yet when all is said and done, state performance usually remains uneven. The poor performance of some states has raised questions about their objectives and capabilities. Moreover, poor performance has not corresponded to lack of need. Many states that lack strong environmental programs have significant pollution problems.¹⁷

Deciding on the Methods of Pollution Control

Given an environmental standard, which level of government is most likely to choose an efficient method of pollution control in order to meet it? Once the standard is set, achieving the maximum net benefits to society in selecting methods of control means, in effect, obtaining that standard at the lowest possible cost to society. The two most common approaches for controlling sources of pollution are direct regulation and incentive-based systems. Both require government involvement (see Box 2).

Five considerations may influence which level of government is most likely to make decisions about control methods that minimize costs to society:

- o *Information.* Which level of government has the most information with which to evaluate the relative cost-effectiveness of controls? Lower levels of government have better information on the least costly method of controlling pollution to meet a given environmental standard, based on their spe-

13. For an overview of enforcement in the United States and Europe, see Steve Ercmann, "Enforcement of Environmental Law in the United States and European Law: Realities and Expectations," *Environmental Law*, vol. 26, no. 4 (Winter 1996), pp. 1213-1239. In the political science literature, see John T. Scholz and Feng Heng Wei, "Regulatory Enforcement in a Federalist System," *American Political Science Review*, vol. 80, no. 4 (August 1986), pp. 1249-1270. The economics literature on enforcement in the context of federalism focuses primarily on taxation. See, for example, William J. Hunter and Michael A. Nelson, "Tax Enforcement: A Public Choice Perspective," *Public Choice*, vol. 82, no. 1 (January 1995), pp. 53-67; and for drug policy, see Kai A. Konrad, "Drug Policy and Federalism," *Public Choice*, vol. 80, no. 2 (July 1994), pp. 55-68.

14. Barry G. Rabe, "Power of the States: The Promise and Pitfalls of Decentralization," in Norman J. Vig and Michael I. Kraft, eds., *Environmental Policy in the 1990s: Reform or Reaction?* (Washington D.C.: Congressional Quarterly Press, 1997), p. 31.

15. Alice Rivlin, *Reviving the American Dream: The Economy, the States and the Federal Government* (Washington, D.C.: Brookings Institution, 1992), p. 92.

16. *Ibid.*, pp. 102-104. See also Ann O.M. Bowman and Richard C. Kearney, *The Resurgence of the States* (Englewood Cliffs, N.J.: Prentice Hall, 1986), p. 11.

17. William R. Lowry, *The Dimensions of Federalism: State Governments and Pollution Control Policies* (Durham, N.C.: Duke University Press, 1992), p. 125.

cific location and particular sources. Thus, considerations about information highlight the advantages of allowing lower levels of government to determine methods of control.

- o *Economies of Scale in Production.* Can the manufacturers of a given control exploit economies of scale in production? When manufacturers make a control for widespread use, economies of scale reduce the per-unit cost of production. Exploiting those economies may reduce the total cost to society of achieving a given environmental standard. Even so, coordinating the selection of control among lower levels of government can involve considerable expense. Thus, considerations of economies of scale suggest potential benefits from in-

volving the central government in determining the methods of control.

- o *Externalities.* Do externalities stem from selecting certain controls? If so, lower levels of government would not bear the full costs of the control methods they chose. As a result, their decisions might not minimize the total cost of pollution control to society. Thus, considerations of externalities offer potential benefits of involvement by central governments in determining control methods.
- o *The Costs of Decisionmaking.* What costs are involved in deciding on specific methods of control? Choosing control methods requires technical capabilities and financial resources to evaluate relative

Box 2.

Government Involvement in Choosing Methods of Pollution Control

Governments may induce firms to adopt pollution controls by direct regulations or by the use of incentive-based systems. With direct regulation, the government must decide how much abatement or what type of pollution control equipment it will require of each source of pollution. The government can try to require pollution reductions for each source in such a way as to achieve the necessary environmental standard at the least cost to society.

Incentive-based systems also involve government decisions and actions. For example, the government could institute a pollution tax—charging sources for each unit of pollution discharged into the environment. Ideally, the government would set the charge so that it encouraged the desired level of abatement, and would then allow sources to respond as they saw fit. Sources with control costs that were lower than the tax would choose abating pollution over paying the tax.

The government might also establish a program for trading pollution permits. If so, it would first determine the total allowable amount of pollution from eligible sources. It would then set up a program for those sources to sell and purchase rights to pollute. Sources with low control costs would cut emissions and sell their right to pollute for a financial net gain. Sources with high control costs would buy that right to pollute rather than incur the greater expense of abatement. Pollution reductions would then take place at

low-cost sources, minimizing the total cost that society incurs to achieve a predetermined environmental standard.

When comparing incentive-based programs with direct regulation, economists generally view the former as more likely to continue to reduce the costs of pollution control over time. For example, individual sources can lower their expenses under a pollution tax by finding ways to reduce pollution at a cost per unit of emissions that is less than the tax. Similarly, under a tradable permit program, a source might find ways to reduce its pollution at a control cost that is less than the cost of buying a permit. Nonetheless, not all pollution-abatement challenges lend themselves to the use of incentive-based systems. Factors that might influence the suitability of incentive-based systems include the extent to which reductions in pollution can be measured, the number of firms in an industry, and the existing legal and institutional structure of the industry.¹

1. For a discussion of those issues, see Robert W. Hahn, "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *Journal of Economic Perspectives*, vol. 3, no. 2 (1989), pp. 94-114; Robert W. Hahn and Gordon L. Hester, "Marketable Permits: Lessons for Theory and Practice," *Ecology Law Quarterly*, vol. 16, no. 2 (1989); and Terry M. Dinan, "Implementation Issues for Marketable Permits: A Case Study for Newsprint," *Journal of Regulatory Economics*, vol. 4, no. 1 (1992), pp. 71-87.

cost-effectiveness. Cost savings may accrue from making a few decisions and then applying them as best suited to individual locations. That potential suggests that involvement by a central government in determining control methods can lower costs.

- o *Government Objectives and Capabilities.* What are the objectives and capabilities of various levels of government? It is essential to be aware of both elements. If certain governments are not seeking to maximize their constituents' welfare—that is, to select control methods that achieve the standard at the lowest possible cost to their constituents—assigning them the responsibility for determining control methods is inappropriate. Similarly, if certain governments do not have the resources and technical expertise to ensure that the chosen methods of control are carried out, assigning them that responsibility is also inappropriate.

Each of these considerations is discussed in detail below. When examined in isolation, some of the considerations point to the advantages of more centralized decisionmaking. Other considerations point to the advantages of more decentralized decisionmaking. Policymakers will want to take all such considerations into account.

Information, however, is the primary consideration in determining which level of government would be most likely to make decisions about control methods that will yield the maximum net benefits to society. When all other factors are equal, lower levels of government are most likely to make the best decisions about control methods because of the information they possess. Obviously, the other considerations listed above may result in important exceptions to that general rule.

Information

The federal government may have excellent general information about the technologies available to reduce pollution. Local officials, however, are likely to have better information about the specific circumstances affecting cost in their communities. Factors such as the composition of industry, the size of the firm, the type of fuel used, equipment, and atmospheric or geological conditions contribute to differences in local cost. Be-

cause those factors vary among communities, lower levels of government generally have better information regarding the cost-effectiveness of control methods in their own area.

For instance, several factors specific to location affect the costs of different control methods for achieving an ambient air standard for particulate matter. The composition of sources that emit particulates varies among locations, and some types of industry may have more cost-effective control options than others. In some cases, a facility's design or the equipment in use may constrain the ability of a source to reduce particulate emissions cost-effectively.

Furthermore, the relationship between local atmospheric conditions and accumulation of pollution may indicate that, based on their exact location, reductions by some sources are more important than others in achieving a given standard. Lower levels of government are better informed about local atmospheric conditions and can use their information to regulate sources directly or to determine appropriate parameters for incentive-based programs. Thus, assigning responsibility for choosing control methods to lower levels of government is more likely to bring about maximum net benefits to society.

Economies of Scale in Production

One possible exception to the general advantage of having lower levels of government select control methods is particularly worth noting—that exception is when controls on manufacturing involve important economies of scale in production. That feature reduces the per-unit cost of manufacturing controls produced for widespread use.

Economies of scale in production arise when a method of control affects the design of a product sold in multiple jurisdictions. For example, suppose that many different states face high costs for waste disposal. Those states might try to increase newspaper recycling by instituting different requirements for recycled content for newsprint sold in their jurisdictions. Complying with many different state requirements would raise the cost of manufacturing newsprint. It would probably be less costly to manufacture one type of recycled newsprint for the whole nation.

To take advantage of economies of scale in production, some uniformity in adopted control methods is necessary. That uniformity avoids one type of excess cost—varying the manufacturing process to reflect different requirements in different areas. Uniformity, however, can impose a second type of excess cost—that borne by areas in which the pollution problem did not merit such controls. For example, moving from regular newsprint to a uniform requirement for recycled content would probably entail some price increase for every state. States without high waste-disposal costs, which do not receive commensurate benefits from increased recycling, would pay the cost of those increased prices. Whether uniformity in selecting controls is desirable depends in part on the relative size of those two types of excess cost.

Suppose the cost savings from exploiting economies of scale in production outweighed the excess cost borne by areas in which the pollution problem did not merit the uniform control. In that case, does the central government have a role in the selection of controls? In principle, lower levels of government could coordinate the selection of controls to agree on a uniform method. Governments whose constituents benefit from uniform controls could compensate governments whose constituents do not. In practice, however, the transaction costs—that is, the administrative and political costs—of negotiating those agreements may be very high.

Externalities

A second possible exception to the general advantage of lower levels of government in selecting methods of control can occur when options involve important externalities. In that case, control methods selected by lower levels of government can impose costs on society, but the constituents of the various governments do not necessarily bear those costs. Those externalities can come into play in at least three different ways.

First, control methods may affect areas outside the decisionmaking jurisdiction.¹⁸ For example, if one area chooses to increase the height of a smokestack to take

advantage of prevailing winds, downwind areas will invariably bear some of the costs of that decision. Similarly, if one state bans the use of coal to reduce acid rain, states producing coal will bear some of the costs of that decision. To cite one possible effect, workers in the coal industry may have to bear transitional costs as they relocate to find new jobs. Lower levels of government do not have the incentive to take such externalities into account. Thus, they may rely on certain methods of control more heavily than is warranted by the goal of achieving maximum net benefits for society.

Second, certain methods of control may have profound effects on future generations. For example, methods chosen to contain hazardous wastes may not have infinite lifetimes. Lower levels of government may not adequately take into account the costs that future generations will bear. That situation can occur when the mobility of the population is such that people do not feel responsible for the conditions their own descendants will face. However, consider what would happen if property values of current constituents reflected expected future costs of control. In that case, lower levels of government would have an incentive to take into account the control costs that future generations would bear.¹⁹

Third, intergovernmental subsidies may affect the relative costs of control methods. Suppose the central government provides grants or low-interest loans for secondary-sewage treatment plants. In such cases, lower levels of government, which do not bear the full costs of the option, may overuse treatment plants. Less costly controls might be available for society as a whole. Governments might find it cheaper, for instance, to construct marshes for natural filtration or to impose taxes on the metered sewage disposal of their constituents.

When lower levels of government do not bear the full costs of selecting control methods because of externalities, their choices may not minimize society's cost of controls. Taking those externalities into account may yield greater cost savings than those from decentralizing the choice of control methods. Under such circumstances, central governments are more likely to

18. This process has been referred to as "cost externalization." See E. Donald Elliott, Bruce A. Ackerman, and John C. Millian, "Toward a Theory of Statutory Evolution: The Federalization of Environmental Law," *Journal of Law, Economics, and Organization*, vol. 1, no. 2 (Fall 1985), pp. 313-340.

19. Oates, "Economics, Economists, and Environmental Policy," pp. 289-296.

make decisions that provide the maximum net benefits to society.

Costs of Decisionmaking

A third possible exception to the general advantage of lower levels of government in choosing control methods may occur when important unit costs stem from the decisionmaking process itself. Choosing among control methods requires evaluating information about the cost-effectiveness of alternatives. Widespread uncertainty about the cost-effectiveness of abatement for specific individual sources can complicate that choice. Choosing the most appropriate controls calls for government resources, both in terms of technical expertise and financial support. Allowing the central government to select uniform controls—or a few controls to be applied as most appropriate within different areas—would reduce decisionmaking costs.

Nevertheless, the federal government—or the private sector—could lower the costs of local decisionmaking by putting technical information into a form useful to lower levels of government. For example, central governments can often obtain materials that explain available technologies for control and could provide information to lower levels of government on the technologies' average cost per unit of pollution abatement. The advantages of local decisionmaking will be greatest when sufficient information exists such that lower levels of government are able to fine-tune the selection of controls based on their unique circumstances.

Government Objectives and Capabilities

Governments will be most likely to choose controls that achieve a given standard at the lowest possible cost if they are making an attempt to maximize the welfare of their constituents. Conversely, governments that favor specific pollution sources or abatement industries over others are not likely to choose efficient controls. For example, lower levels of government might overvalue the importance of attracting business investment to their jurisdiction. Placing lax control requirements on

new facilities might attract businesses, but it would also sacrifice minimizing the costs of pollution control.

Determining whether governments make less-than-optimal choices about control methods to attract industry is extremely difficult. Nevertheless, concern about that possibility was one factor that led to establishing minimum federal requirements for new sources of air pollution. The House Committee report on the 1970 Clean Air Act stated that those standards would "preclude efforts on the part of the states to compete with each other in trying to attract new plants and facilities without assuming adequate control of large-scale emissions therefrom."²⁰ That strategy, however, has its own potential for inefficiency. Requirements that affect only new sources may create an incentive for older, more polluting facilities to stay in operation longer than they otherwise would. Moreover, controlling emissions from older facilities can be particularly expensive.

In some instances, governments may be able to choose appropriate methods of control, but they may be unable to establish the necessary program to put those controls in place. However, choosing control methods and putting those choices in place can be separate activities. One level of government may be best suited to make optimal choices about control methods, while another is best suited to enforce those decisions.

Determining and Funding the Basic Research Agenda

Developing environmental protection programs that will achieve maximum net benefits for society means that policymakers require information about the effects of pollution on human health and the environment. That information, generated through basic scientific research, essentially has the characteristics of a "public good." A public good is a commodity that, once supplied to one person, is available to additional parties at no extra cost. That contrasts with a private good. Once a person consumes a unit of a private good, it is no longer available for consumption by additional parties. Because one person's consumption of a public

20. Bartik, "The Effects of Environmental Regulation on Business Location in the United States," p. 24.

good does not reduce its availability to anyone else, it exhibits "nonrival consumption."

Which level of government is most appropriate for determining and funding a research agenda on the human health and environmental effects of pollution? In general, assigning those responsibilities to the federal government is most appropriate. That is because the public good generated by the research exhibits nonrival consumption: information provided by the federal government is available to serve all members of society. Policymakers at the federal level are in the best position to incorporate that fact into their decisions. Specifically, they can most accurately determine the optimal research agenda because they would weigh the cost of conducting such research against the benefits that they expect multiple states to receive from it.

In contrast, assume state governments had responsibility for research on the health and environmental effects of ambient air pollutants. A given state would weigh the cost of conducting that research against the benefit provided to its own citizens. It would not consider the potential benefit provided to citizens of other states. Thus, individual states do not have the appropriate incentive to conduct a level of research that would bring about maximum net benefits to society. They would tend to underinvest in research. Further, if multiple states pursued similar research, resources would be wasted on duplication of effort.

Federal policymakers also have the necessary scope of authority to ensure that all potential beneficiaries share the cost of that research. Another solution is for all beneficiaries to volunteer to pay for the good. The problem with that alternative, however, is that beneficiaries may try to be "free-riders"—they may conceal the true value they place on the good to avoid paying for it. For example, suppose state governments were responsible for conducting research on the health and environmental effects of ambient air pollutants. Some states might postpone their own research efforts in the hope that other states would conduct the desired studies.

In addition to the free-rider phenomenon, other factors can contribute to significant transaction costs of negotiations among states if they jointly attempt to provide a public good. For example, the states may disagree on how to allocate research costs among them-

selves. Some states might want to base funding shares on an ability to pay. Others may want funding shares to correspond to the likely level of benefits received from the research. Moreover, the states may disagree on setting research priorities. Governments may also be particularly sensitive to the potential political costs of how constituents perceive the resulting cooperative agreement.

The larger the number of parties involved, the more costly the negotiations are likely to be. Thus, when an environmental problem affects many states, the federal government is often in the best position to handle the responsibilities for research most efficiently.

The Federal Government Is Generally Best Suited to Take Responsibility for Basic Research

The example of ambient air pollution discussed above highlights the two key aspects of the federal government's advantage in providing a level of the public good that achieves maximum net benefits for society. First, because the environmental problem is widespread, the federal government is in the best position to identify the associated costs and benefits. Thus, it can best determine the most appropriate research agenda. Second, with the federal government taking responsibility for funding the research, society can avoid problems of free riders and the high cost of multiparty negotiations.

When Might Lower Levels of Government Be Assigned Responsibility for Basic Research?

Suppose the effects of a certain type of pollution have a more limited geographic scope. In that case, the federal government may not be in the best position to make the most efficient decisions about research. For example, the Chesapeake Bay states—Maryland, Pennsylvania, Virginia, and the District of Columbia—may collectively be in a better position than the federal government to identify the costs and benefits of research on how pollution affects organisms that are indigenous to the Chesapeake Bay area.

Moreover, when pollution problems have a more limited geographic scope, the potential number of beneficiaries of the research is small. With fewer concerned parties and a well-identified problem, lower levels of government might conduct negotiations without incurring significant transaction costs. For example, the costs of negotiations among only the four Chesapeake Bay states might be relatively small. If so, the benefits of their advantage in identifying appropriate research for that area could outweigh the costs of cooperative decisionmaking.

How often do prevailing circumstances favor assigning research responsibilities to lower levels of government instead of the federal government? In practice, the federal government is usually the most appropriate one to determine and fund basic research on the effects of pollution, since research on many pollution problems has widespread applications. Policymakers rarely know with certainty that pollution problems are limited to a certain geographic area. For example, research on the effects of nitrogen and phosphorus on the Chesapeake Bay is at least partly transferable to nutrient-related pollution problems that affect other water bodies. In general, nutrients nourish blooms of algae that rob the water of life-giving oxygen. Thus, specific circumstances often point to a role for the federal government in determining and funding the research agenda.

Nonetheless, because of the uniqueness of the Chesapeake Bay, some research results may pertain solely to the Chesapeake Bay states. For example, sci-

entists build models to assess the contributions of tributaries to nutrient pollution in the Chesapeake Bay. The public good—in this case, the information produced by those models—serves only the Chesapeake Bay states. If negotiation costs are low, state policymakers may be in the best position to make decisions about the type of research that would maximize welfare.

When a pollution problem affects the jurisdiction of only one state, county, or town, the argument for that level of government's assuming research responsibilities on the basis of efficiency is even stronger. For example, mercury has not typically been found in drinking water outside New Jersey. Thus, the state has a comparative advantage in identifying the costs and benefits of basic research on the effects of having that contaminant in drinking water. Moreover, the state government of New Jersey can use its authority to tax to fund the relevant research, thereby avoiding the problems of free riders and costly negotiations among beneficiaries.

One might also see cooperative agreements by different levels of government to pursue and fund a comprehensive research agenda on a pollution problem. Such an approach can appropriately address the need for public goods with different groups of beneficiaries while using cooperation to strengthen the effectiveness of individual research efforts. In some cases, private industry may also become involved because of the potentially important influence of research results on industrial activity.

Case Study of Drinking Water Protection

The Safe Drinking Water Act (SDWA) has an impact on nearly every citizen. Approximately 200,000 public water systems are currently serving 243 million people living in the United States. A public water system provides piped water to an average of at least 25 people for at least 60 days a year. The remaining population gets water from private wells. The Environmental Protection Agency has the most information about community water systems, which are a subset of public water systems that serve the same population year-round.

Most community water systems are small—over 85 percent serve less than 3,300 people. However, large water systems serve most of the population. Nearly 80 percent of the population receives water from systems that serve more than 10,000 people. Similarly, the number of groundwater systems is more than four times that of surface water systems. Yet surface water systems serve over 60 percent of the population. Local governments operate approximately 80 percent of all community water systems, and the remainder are privately owned. All public water systems are subject to the same SDWA regulations. Exceptions are the few requirements that apply only to surface water systems.

The Congress passed the SDWA in 1974 and established the first set of federally enforceable standards for drinking water. Before the SDWA, the federal Public Health Service published those standards. However, compliance with those standards was voluntary, except for systems supplying water to interstate carriers. In 1986, the Congress amended and considerably

strengthened the SDWA. Since then, the Environmental Protection Agency has issued standards for 84 contaminants. In addition, it has specified treatment requirements under the Surface Water Treatment Rule and the Total Coliform Monitoring Rule. Furthermore, the EPA has proposed four more rules that set standards (or treatment requirements) for individual contaminants or groups of contaminants.

The Congress recently amended the SDWA again. The 1996 amendments provide the EPA with more flexibility to consider costs and benefits in setting standards. Those amendments also allow the EPA and the states to provide exceptions for systems that find it costly to meet standards.

Based on data from the EPA, the annual cost to the nation of complying with the existing rules is \$1.4 billion. However, the American Water Works Association, a group of major private suppliers of drinking water, believes that the cost is more than \$4 billion. The EPA estimates that the proposed rules in their current form could ultimately more than triple the total costs of compliance.¹

The existing and proposed rules result in benefits that may be grouped into three categories—reductions in cancers, sublethal chronic health effects (such as neurological or cardiovascular effects), and acute health

1. Congressional Budget Office, *The Safe Drinking Water Act: A Case Study of an Unfunded Federal Mandate* (September 1995), pp. 11-12.

effects (such as gastrointestinal disorders). Most of the regulations issued under the SDWA will set standards for substances based, in whole or in part, on evidence that they are carcinogenic.²

Economic principles suggest guidelines for assigning responsibilities for environmental protection to different levels of government. This chapter examines how that guidance applies to drinking water protection. Specifically, the chapter examines which level of government is most likely to make decisions that result in maximum efficiency for three aspects of protection:

- o Choosing drinking water standards;
- o Deciding on the methods of treatment used to meet a drinking water standard; and
- o Determining and funding the basic research agenda on drinking water issues.

For each aspect, the chapter applies guidance from the perspective of economists on federalism to the specifics of protecting drinking water (see Chapter 1). In addition, the current division of responsibility is compared with that guidance. The federal government currently identifies uniform drinking water standards that all public drinking water systems must meet, unless they qualify for special exceptions. Water systems may choose the technology that they will use to meet the federally determined standards, subject to state approval. Finally, the federal government conducts research on the threats posed by contaminants and the cost-effectiveness of different technologies for treating drinking water.

Choosing Drinking Water Standards

The federal government currently sets standards for drinking water protection. However, most of the costs and health benefits of standards for drinking water are local. Hence, a rationale exists for allowing individual

states, or even local communities, to choose their own drinking water standards. Given the general lack of externalities—costs and benefits that extend beyond local boundaries—standards that achieve maximum local net benefits (benefits minus costs) will also achieve maximum net benefits for the nation. Thus, local governments have an incentive to choose efficient drinking water standards.

Considerations of information highlight the advantages of decentralized standard setting. The per-household cost of drinking water treatment varies greatly among communities—particularly given the pronounced differences in the size of water systems. Preferences for drinking water protection also vary among communities. As such, local governments are in the best position to choose standards that reflect those variations in costs and preferences. In contrast, federal standards impose welfare losses (a decrease in net benefits) on communities when they fail to account for their unique local circumstances. The welfare losses from federal standards will be greatest when those standards are uniform. If federal standards were varied based on the size of drinking water systems, welfare losses would be reduced. Standards that vary with the size of the system, however, would still not reflect the variations in the preferences of individual communities.

This study analyzes the size of welfare losses that might result from one standard that the EPA is proposing. That analysis highlights the pattern of welfare losses that a uniform standard creates—namely, that welfare losses increase rapidly as the size of the water system decreases. That pattern stems from the large economies of scale in treating drinking water and is likely to be found for most—if not all—uniform drinking water standards. Those welfare losses would, of course, diminish if the EPA varied federal standards to reflect local circumstances. Welfare losses for small systems should diminish if “variance technologies”—which are defined under the 1996 amendments—are widely used. The EPA and the states must overcome several hurdles, however, before variance technologies are used on a widespread basis.

The local nature of costs and benefits stemming from drinking water standards and considerations of information underscores the advantages of local standard setting. Other considerations, however, may offset such advantages. One such consideration is whether

2. Environmental Protection Agency, *Estimates of the Total Benefits and Total Costs Associated with Implementation of the 1986 Amendments to the Safe Drinking Water Act* (March 1990), p. 2-1.

state or local governments would choose—and carry out—efficient standards without federal requirements.

A second consideration falls under the category of externalities—that is, effects on other states and localities. Individuals may attach a value to knowing that all people living in the United States drink water that meets certain standards. Some communities, however, would not choose such standards based on their own preferences. If the nation places a high value on ensuring that minimum safety standards are met—and is unwilling to accept local decisions—it may provide a justification for overriding local preferences.

The Current Process for Setting Standards

Under current legislation, the Safe Drinking Water Act directs the EPA to establish maximum contaminant level goals (MCLGs). Those are nonenforceable goals set at a level at which no known or anticipated adverse health effects occur.³ Next, the SDWA directs the EPA to set an enforceable standard called a maximum contaminant level (MCL). The EPA is to set that standard as close to the MCLG as is affordable to large water systems with relatively clean source water.⁴

Historically, the SDWA did not allow the EPA to weigh costs against anticipated benefits when setting an MCL. However, the 1996 amendments now allow it to do so. The SDWA directs the EPA to set the MCL based on what is affordable to large systems. The amendments allow the EPA to modify the MCL if the costs incurred by large public drinking water systems—and smaller systems that are unlikely to receive variances—are not justified by the benefits the systems receive. Systems that serve 10,000 people or less are eligible for variances under certain conditions. First, they must be unable to afford to meet the MCL. Second, the state must determine that granting the variance

will ensure adequate protection of human health. Third, the EPA must have defined a relevant variance technology.

Specifically, the amendments state that if the benefits of the maximum contaminant level that is found to be "feasible" (that is, affordable to large systems) do not justify the costs, then the EPA may set an MCL that "maximizes health risk reduction benefits at a cost that is justified by the benefits." That criterion for large systems is used unless the standard under consideration applies to a contaminant that is found almost exclusively in small systems.

In some cases, such a change will lower the maximum contaminant level. It will not, however, ensure that the benefits of meeting the MCL outweigh the costs for all systems. Since significant economies of scale occur in treating drinking water, small systems may incur greater costs than benefits when they comply with the MCL.

Economies of scale mean that the per-household cost of treatment is higher for small systems than for large systems. However, the per-household health benefit of treatment does not vary with the system's size. As a result, small systems typically bear a greater financial burden (that is, a higher per-household cost) to meet national standards. In addition, they experience a less favorable benefit-to-cost ratio for any given standard. Large systems tend to dominate analyses of total costs and benefits because those systems serve most of the population. Standards that pass an aggregate benefit-to-cost test therefore may not be efficient for small systems.

The 1986 and 1996 amendments try to provide both the EPA and the states with flexibility in carrying out the SDWA standards. Those amendments specify exceptions aimed at systems that have technical or economic difficulty in meeting federal drinking water standards.

According to the 1986 amendments, the EPA may grant variances to systems that have highly contaminated source water (for example, surface water or groundwater), since those systems would be unable to meet the standards even after they installed the best technologies available. In addition, the EPA may grant exemptions to systems that are unable to meet a stan-

3. Maximum contaminant level goals are defined as "nonenforceable health-based goals that are set at the level at which no known or anticipated adverse effects on the health of persons occur and which allow for an adequate margin of safety." See Environmental Protection Agency, *Technical and Economic Capacity of States and Public Water Systems to Implement Drinking Water Regulations: Report to Congress* (September 1993), p. 22.

4. Ibid.

dard because of "compelling factors." Those factors may include economic difficulty.

In reality, however, variances and exemptions are rarely used. For example, no variances and only 15 exemptions were issued between January 1990 and March 1994.⁵ Given that approximately 200,000 public water systems are subject to federal regulations (of which over 85 percent are small), that is a strikingly small number. Many barriers prevent more frequent use of those provisions:

- o A state may find it costly to set up a program to provide variances and exemptions.
- o The EPA and the states may grant a variance only if it does not result in "unreasonable risk." However, unreasonable risk is difficult to determine.
- o States may be concerned about public perceptions of allowing some systems not to meet standards.
- o Economic infeasibility may be a justification for an exemption. However, no clear agreement exists on how the EPA and the states should determine affordability.

The 1996 amendments include more provisions designed to provide relief for systems that would experience a large financial burden to meet the SDWA standards. Those amendments require the EPA to establish "variance technologies" for three categories of alternative-sized systems. Those size categories range from systems serving 25 people to those serving up to 10,000 people. As defined by the amendments, variance technologies are ones that are "affordable" and that are "protective of public health," although they may not achieve the maximum containment level.⁶ States may grant permission for systems that fall into the relevant-sized categories to use variance technologies on a case-by-case basis.⁷

5. Congressional Budget Office, *The Safe Drinking Water Act*, p. 36.

6. U.S. House of Representatives, *Safe Drinking Water Act Amendments of 1996*, conference report to accompany S. 1316, Report 104-741 (August 1, 1996), p. 21.

7. Most states have "primacy," meaning that they administer the Safe Drinking Water Act in their state. In a case in which a state did not have primacy, the Environmental Protection Agency would determine whether a system was eligible to use a variance technology.

States may allow systems to use variance technologies only if two conditions are met. First, the state must decide that the system cannot afford to comply with the MCL by treating the water, using an alternative water source, or consolidating with another system. Second, the state must decide that using a variance technology will ensure "adequate protection of human health." Furthermore, systems that serve between 3,300 people and 10,000 people may obtain a variance only if they receive approval from both the state and the EPA. Those attempts to provide small systems with relief from uniform standards will be successful only if the EPA and the states can put them into practice.

The Consistency of Current Practice with Economic Principles

As discussed in Chapter 1, five considerations influence which level of government is most likely to choose efficient standards. The following considerations are those most relevant to drinking water protection. Considerations are grouped together when that is useful.

Externalities. Do the costs and benefits from environmental protection efforts extend beyond local or state boundaries? That issue is the primary consideration when deciding which level of government is most likely to have an incentive to choose an efficient standard. In general, when the answer to that question is no, a stronger rationale exists for allowing localities or states to set their own standards. Conversely, if the answer to that question is yes, a stronger rationale exists for setting standards at the regional or national level.

Contaminants in drinking water can result in cases of cancer or chronic health effects only after a long period of exposure. Consequently, only the local citizens who regularly use the water system receive the benefits of efforts to protect against those types of contaminants. Most of the standards issued under the SDWA have health benefits that fall into that category.

However, some of the more costly requirements—the Surface Water Treatment Rule and the Total Coliform Monitoring Rule—protect people from pathogens that result in acute effects after only short-term exposure. As such, visitors to an area would benefit from their control. Even so, the local population is the primary beneficiary of controls for contaminants

that result in acute effects. If controls are inadequate, the local population has the greatest chance of drinking the water when harmful contaminants are present. An exception to that principle is sulfate, for which the EPA is proposing a standard. Visitors to an area are the primary beneficiaries of regulating sulfate, because local residents become acclimated to high levels of it over time.

Communities that have many visitors for either tourism or commerce will provide health benefits for nonresidents by controlling contaminants that cause acute effects. Those communities have an economic incentive, however, to provide the health benefits that visitors receive. They could experience a significant financial loss if an outbreak of waterborne disease discouraged tourism or commerce from their area.

Like most of the benefits, the costs of treating drinking water fall on local citizens. Treatment costs might include capital equipment and any operating and maintenance expenditures. Those costs are passed on to customers of the water district.

But what happens in the cases of a "safety-concern" externality? Nonresidents may attach a value to knowing that residents of Community X drink water that meets a certain level of safety. Yet Community X will not consider that externality and may want to choose a lower level of protection than is desirable from a national perspective. Even when a safety-concern externality exists, the value of that external benefit would need to be quite high to provide an economic justification for all communities to apply minimum federal standards to many types of contaminants. For small systems, the large economies of scale in drinking water treatment mean that the costs of treating those contaminants may far outweigh the health benefits.

Information and Decisionmaking Costs. Setting efficient standards requires evaluating information on the costs of and benefits from alternative standards. Local officials are likely to have a better understanding of the local circumstances that affect the cost of treatment than the federal government does. Those circumstances include local labor rates, the cost of issuing municipal bonds, and the treatment technologies already in place.

Moreover, local officials usually have better information on the specific priority that their community

attaches to drinking water treatment compared with other community needs. For example, communities with a large elderly population may attach a relatively high priority to controlling pathogens, since elderly people are particularly vulnerable to them. At the same time, federal officials are likely to have better information on the relationship between contaminant levels and health effects than are state or local governments.

Considerations of information favor setting standards for drinking water at the local level. Having the federal government disseminate general information on the effect of contaminants on health is less costly than having lower levels of government transfer specific information about each community.

Information, of course, affects local preferences. Citizens can express preferences about drinking water standards only if they are well informed. The 1996 amendments include provisions designed to ensure that they are. Those amendments require drinking water systems to issue annual consumer confidence reports, which must inform citizens about the contaminants in their drinking water and the potential health effects of those contaminants.⁸ Moreover, the federal government could require drinking water systems to issue those reports even if the standards were locally determined.

Federal standards for drinking water that fail to account for the variation in costs and preferences among communities will impose "welfare losses" on some communities. That is, federally determined standards may force communities to choose higher standards than their unique circumstances justify. Those higher standards reduce the net benefits that the community receives from treating drinking water. That decrease in net benefits is called a welfare loss. Because of the large economies of scale in drinking water treatment, federal standards that reflect average circumstances will often impose large welfare losses on communities served by small systems.

However, choosing a drinking water standard requires government resources. Decisionmaking costs will typically be less if the federal government chooses standards than if each individual state or local community selects its own. The federal government generally

8. U.S. House of Representatives, *Safe Drinking Water Act Amendments of 1996*, section 114, p. 28.

selects a few standards (or a single standard) and applies them as appropriate to all communities, which clearly keeps decisionmaking costs down.

Certain information, however, may help localities to lower their decisionmaking costs. For example, the federal government—or the private sector—could provide guidelines to local communities. Those guidelines might indicate drinking water standards that are appropriate under average conditions. Lower levels of government could then choose the actual level of the standard based on local circumstances. Putting scientific information into a form that is accessible to local decisionmakers would be an essential part of enabling local governments to make informed decisions about drinking water standards.

However, another factor might increase decision-making costs if local governments chose the standards: the boundaries of water systems do not always correspond with political boundaries. Hence, some type of interjurisdictional agreement may be needed, which would involve transaction costs.

Government Objectives and Capabilities. The potential gains in efficiency from decentralized standard setting will be realized only if local governments choose standards that will increase the net benefits of their constituents to the greatest extent possible. Moreover, they must have the ability to see that those standards are met. If some communities are unable—or unwilling—to choose and put in place appropriate drinking water standards, then imposing federal standards might be warranted. Federal standards can result in welfare gains for people living in communities that would not ordinarily choose efficient local standards. However, federal standards also impose welfare losses on communities required to undertake more treatment measures than are justified by their local circumstances. Thus, federal standards are justified if the welfare gains that they create are larger than the welfare losses that they cause.

In deciding whether federal standards are necessary, a crucial issue is whether state or local governments would choose efficient standards. It is also a very difficult one. In an attempt to shed some light on that issue, this study addresses two questions: what led to the current strong federal role in protecting drinking water, and are those factors still relevant today?

A Thumbnail History. Long before the Environmental Protection Agency was established and the Safe Drinking Water Act was enacted, local governments treated their drinking water to ensure acceptable taste and odor and to prevent the outbreak of acute waterborne disease.⁹ Cities passed laws to prevent the dumping of foreign matter into their water supplies in the early 1880s.

Yet inadequate scientific knowledge and lack of control technologies led to widespread waterborne disease. For example, between 1861 and 1870, the national typhoid fever rate averaged 120 per 100,000 people. That epidemic, as well as new information on bacteriological risks, led to the formation of state boards of health. Moreover, the development of new treatment technologies in the late 1800s brought about a drastic reduction in waterborne disease. In fact, by 1918, the nation's typhoid fever rate had fallen to less than 10 per 100,000 people.

Establishing the Public Health Service's (PHS's) Hygienic Laboratory in 1901 represented the initial federal action on drinking water. That laboratory investigated infectious diseases. In 1914, the PHS developed criteria to test supplies of drinking water used by interstate carriers. Over time, those standards were applied to water distributed by municipalities. The PHS revised the standards in 1925, 1946, and 1962. By 1971, all 50 states had accepted the PHS drinking water standards (some with minor modifications) as either regulations or guidelines. However, the federal government mandated use of those standards only for water supplies used by interstate carriers.

Recent Developments. Several events led to passing the Safe Drinking Water Act in 1974, which considerably expanded the federal role in protecting drinking water. First, although waterborne diseases had been virtually eliminated since the 1930s, they began to re-

9. The discussion of treating drinking water before the passage of the Safe Drinking Water Act and of the factors that led to its passage is drawn from Thomas J. Douglas, "Safe Drinking Water Act of 1974: History and Critique," *Environmental Affairs*, vol. 5 (Summer 1976); Statement of Robert W. Fri, Deputy Administrator, Environmental Protection Agency, before the Subcommittee on Public Health and Environment of the House Committee on Interstate and Foreign Commerce, March 8, 1973; "Safe Drinking Water," *Congressional Quarterly Almanac*, 93rd Congress, Second Session, vol. 30 (1974); and William A. Oleckno, "The National Interim Primary Drinking Water Regulations: Part I—Historical Development," *Journal of Environmental Health*, vol. 44, no. 5 (March/April 1982).

emerge during the 1960s. During that decade, 130 outbreaks of waterborne diseases were reported. One explanation for that reemergence is that states focused less on drinking water safety because of the dramatic decrease in waterborne diseases during the first half of the 20th century. Another explanation is that states switched often limited resources away from safe drinking water programs to deal with other kinds of water pollution. The inception of the federal water pollution program in 1948 may have diverted attention to stopping the discharge of pollutants into lakes and streams.

In response to the reemergence of waterborne disease, the Bureau of Water Hygiene of the Public Health Service undertook a study of public water systems in 1969. That study played an important role in generating Congressional interest in legislation on drinking water. It exposed deficiencies in the quality of drinking water. It also criticized the surveillance of water systems by state and local officials. The study noted that the Public Health Service based many of its drinking water standards on insufficient data. The study also stated that the Public Health Service had not set standards for many contaminants found in drinking water. The study concluded by highlighting the need for more research, and it recommended expanding state and federal programs to train the water systems' personnel.

A second factor that led the Congress to pass the Safe Drinking Water Act was a deep concern about the many new chemical pollutants introduced into water supplies following World War II. Some people feared that the technology for treating drinking water was not advancing rapidly enough to address those types of pollutants.

Two reports—one by the Environmental Defense Fund and the other by the Environmental Protection Agency—linked certain pollutants found in drinking water with cancer. Those reports provided the final impetus needed to pass the Safe Drinking Water Act. The EPA has set many standards under the SDWA. Federal responsibility for setting standards, however, has not guaranteed the safety of drinking water. For example, 104 people died in a 1993 outbreak of gastroenteritis in Milwaukee, Wisconsin. Federal standards had not adequately controlled the pathogen responsible for that outbreak.

State and local governments made significant strides in protecting drinking water before the 1974 passage of the SDWA. Those actions resulted in a dramatic decrease in waterborne disease and the adoption of voluntary federal guidelines in all 50 states. However, the Congress established the SDWA, in part, out of a concern that efforts by state and local governments to protect drinking water were not adequate.

A more difficult question, however, is whether state and local governments would ensure sufficient protection without federal standards today. Some people argue that the general capability of state governments has improved considerably since the 1960s, which is probably the case for drinking water protection.¹⁰ Currently, 49 states have primacy—meaning that they are responsible for enforcing drinking water standards in their state. Those states, therefore, have a certain degree of expertise.

In some cases, however, state enforcement efforts have been criticized. For example, the General Accounting Office (GAO) found that many states "lack the resources needed to identify nonviable water systems and ensure that they are brought into long-term compliance with drinking water standards."¹¹ Furthermore, the GAO examined enforcement in six states. It found that enforcement was inadequate in the six states and failed to bring violators into compliance.¹² As for local governments, they do not currently have a role in either selecting or enforcing standards.

When appropriate, different levels of government could work together. One level of government could choose drinking water standards, and another could design and carry out the program to achieve those standards. For example, local governments might choose standards based on their superior knowledge of unique circumstances affecting costs and benefits. However,

10. Alice Rivlin, *Reviving the American Dream: The Economy, the States and the Federal Government* (Washington, D.C.: Brookings Institution, 1992), p. 92; and Ann O.M. Bowman and Richard C. Kearney, *The Resurgence of the States* (Englewood Cliffs, N.J.: Prentice Hall, 1986), pp. 1-31.

11. General Accounting Office, *Drinking Water: Stronger Efforts Essential for Small Communities to Comply with Standards*, GAO/RCED-94-40 (March 1994), p. 3.

12. General Accounting Office, *Drinking Water: Compliance Problems Undermine EPA Program as New Challenges Emerge*, GAO/RCED-90-127 (June 1990), p. 3.

state governments, or the federal government, might enforce those standards in some—or all—localities.

Quantifying the Welfare Losses from Using a Uniform National Standard

This study examines welfare losses that would result from a uniform federal standard for a form of radio-nuclides called adjusted gross alpha emitters.¹³ The EPA classified those pollutants as human carcinogens and proposed a standard of 15 picocuries per liter (pCi/L). The Congressional Budget Office estimates welfare losses on a per-household basis and for the nation as a whole.

Right now, 84 standards and four proposed rules exist for drinking water. Those rules propose standards for either individual or multiple contaminants. To understand fully the implications of imposing uniform national standards, the welfare losses should be estimated for each of the existing and proposed standards. Data limitations, however, preclude that. To calculate the welfare loss that a standard imposes on a community, one must evaluate the costs and benefits the community would receive under that standard as well as under alternative standards. Data on costs and benefits for existing and proposed standards are often not available. In even more cases, data on the costs and benefits of alternative standards are not available. Those data are available, however, for the proposed standard for adjusted gross alpha emitters.

Although that standard was selected based on the availability of data, an important factor contributing to welfare losses from that standard is not unique to it—that is, the large economies of scale in the treatment technology. That phenomenon applies to nearly all other technologies for treating drinking water.

Limitations of This Analysis. This analysis provides important insights into the potential welfare losses that

uniform standards may create. The reader, however, should keep several limitations in mind:

- o The EPA proposed the standard for adjusted gross alpha emitters before the 1996 amendments were passed. The 1996 amendments may reduce welfare losses from standards that are proposed in the future. Further, the 1996 amendments may affect the final standard that the EPA issues for adjusted gross alpha emitters.
- o This analysis does not account for the possible existence of a safety-concern externality.
- o No one knows how many local communities would choose efficient drinking water standards if federal standards were not in place. This analysis initially assumes that communities would choose the level of treatment that provides the greatest possible net benefits. Welfare effects are then reestimated under the alternative assumption that communities would not undertake any treatment without federal standards. For the particular contaminant examined in this study—adjusted gross alpha emitters—welfare effects are essentially the same under those two alternative assumptions, since "no treatment" is the most efficient course of action for nearly all communities. For other contaminants, however, the issue of whether local governments would choose efficient local standards may be a key factor in determining the need for federal standards.
- o High compliance costs may force some drinking water systems to consolidate. When consolidation is possible, it will lower per-household compliance costs. No data exist on the potential for systems affected by the proposed rule to consolidate. CBO therefore estimated costs based on the existing number of systems.

Assumptions. The analysis used conservative assumptions in calculating potential welfare losses resulting from the proposed standard. Those assumptions provide upper estimates of the possible net benefits from the standard and therefore reduce estimates of potential welfare losses. If significant welfare losses were found under those assumptions, then the case against the proposed standard on the grounds of efficiency would be a strong one. The assumptions are as follows:

13. The analysis presented in this study benefited from input by Maureen Cropper of the World Bank and the University of Maryland and Paul Portney of Resources for the Future. One of the authors of this study participated in an analysis with Cropper and Portney. See Terry M. Dinan, Maureen L. Cropper, and Paul R. Portney, "Environmental Federalism: Welfare Losses from Uniform National Drinking Water Standards," in Arvind Panagariya, Paul R. Portney, and Robert M. Schwab, eds., *Environmental Economics and Public Choice: Essays in Honor of Wallace E. Oates* (Brookfield, Vt.: Edward Elgar Publishing, forthcoming).

- o One isotope—polonium 210—causes all violations of the adjusted gross alpha standard. Adjusted gross alpha emitters include several radioactive isotopes, of which polonium 210 poses the greatest cancer risk. In other words, a given decrease in the measure of adjusted gross alpha emitters will result in the maximum reductions in cancer under this assumption.
- o Each cancer case avoided has a value of \$10 million. That assumption is conservative because most recent studies value a statistical life closer to \$5 million.¹⁴ In addition, not all cancers will result in premature mortality.
- o Systems remove only as much of the contaminant as is necessary to meet the proposed standard.¹⁵ The EPA's estimate of the cost of meeting the proposed standard assumes that each system would remove as much of the contaminant as is technically possible. Had that assumption been used, it would have yielded a correspondingly higher estimate of welfare losses.

Results. Welfare effects are calculated for systems in different-sized categories and with different initial concentrations of adjusted gross alpha emitters (see Table 2). To calculate the welfare effects, this study calculated the difference between the net benefits that systems would receive under optimal treatment and the net benefits that they would receive under the proposed standard.

Welfare losses vary greatly among different-sized systems, with households served by small systems in-

curing large losses. In fact, households served by systems in the smallest-sized category may incur losses ranging from \$651 to \$774 per year, depending on the systems' initial level of contamination. The welfare losses that households experience drop rapidly as the size of the system increases. That pattern is a result of the large economies of scale in drinking water treatment. Per-household treatment costs are higher for small systems, but per-household benefits are not.

No households experience welfare gains as a result of the proposed standard. Welfare effects are equal to the net benefits that systems incur when they meet the federal standard minus the net benefits they would receive without a federal standard. Initially, this study assumed that without a federal standard, systems would choose the level of treatment that best reflects their local circumstances and thus maximizes their net benefits. In other words, systems that benefited from reducing adjusted gross alpha emitters to the level of 15 pCi/L would have done so even without a federal standard. Positive net benefits from treating to the required level, therefore, are not classified as gains in welfare from meeting the standard.

An alternative is to assume that systems would not undertake any treatment without federal standards. Positive net benefits from treating drinking water to the required level would then count as welfare gains from meeting the proposed standard. However, only one system was found to have positive net benefits under the proposed standard. Consequently, when the alternative assumption is made, the welfare results from meeting the proposed standard for adjusted gross alpha emitters do not change significantly. However, the alternative assumption could cause other federal standards to bring about larger welfare gains, as will be the case when more systems have positive net benefits at the proposed level of the standard in question.

Would the proposed standard for adjusted gross alpha emitters be justified by the safety-concern externality described above? One way to answer that question is to examine the cost per case of cancer avoided that systems in the smallest-sized category incur when they comply with the proposed standard. That cost is \$480 million. The high cost per case of cancer avoided stems from the extremely small decrease in cancer risk that the standard brings about for households served by those systems. The actual number of

14. W. Kip Viscusi, "The Value of Risks to Life and Health," *Journal of Economic Literature*, vol. 31, no. 4 (December 1993). Valuing a statistical life at \$5 million means that a city with a population of one million would be willing to pay \$5 million for a regulation that was expected to reduce each resident's risk of dying prematurely by one in one million.

15. Based on the Environmental Protection Agency data, this study assumes that systems will use reverse osmosis to remove adjusted gross alpha emitters. The alpha emitters are not removed by other technologies that might be installed to remove other types of contaminants. Once installed, reverse osmosis will remove other radionuclides not included in the measure of adjusted gross alpha emitters—specifically, uranium, radium 226, and radium 228. However, those other radionuclides are not expected to occur in the same system as adjusted gross alpha emitters. See Environmental Protection Agency, "Proposed Rule: National Primary Drinking Water Regulations for Radionuclides," *Federal Register*, vol. 55, no. 138 (July 18, 1991), p. 33103.

cancer cases avoided by people served by systems in the smallest-sized category is estimated at less than 0.01.

The benefits of the proposed standard would outweigh the costs for those systems only if the cancer cases avoided are assigned a value of \$480 million—not the \$10 million value used in this analysis. The proposed standard would be efficient, therefore, only if the premium that the nation placed on ensuring that all households receive that level of protection was extremely large.

CBO estimates large annual welfare losses for households served by small systems requiring treatment under the proposed rule. However, relatively few households are expected to incur those losses, because the EPA does not expect many systems to have initial

contamination levels above the proposed standard of 15 pCi/L. Based on the EPA data, only 123 systems (out of a total of more than 60,000 community water systems) are expected to exceed the proposed standard (see Table 3). Of those, the vast majority are small systems serving relatively few households. A total of 178,991 households are estimated to incur welfare losses. That amount is the sum of all households with concentration levels greater than 15 in categories of size with welfare losses—that is, systems serving up to 75,000 people (see Table 4).

According to CBO estimates, the total welfare loss among all households from the proposed standard is \$12 million annually. The \$12 million total is reached using a two-step process. First, each estimated welfare loss in Table 2 is multiplied by the number of households expected to incur that loss. Next, those losses are

Table 2.
Welfare Effects per Household of Meeting the Proposed Standard for Adjusted Gross Alpha Emitters
(In 1986 dollars)

Size of System (Number of people served)	Effects on Households at an Initial Concentration (Picocuries per Liter) of:				
	20	25	30	35	50
25 to 100	-651	-706	-738	-756	-774
101 to 500	-266	-313	-339	-341	-329
501 to 1,000	-95	-172	-219	-227	-225
1,001 to 3,300	-85	-128	-153	-156	-147
3,301 to 10,000	-67	-85	-93	-91	-71
10,001 to 25,000	-55	-63	-64	-60	-38
25,001 to 50,000	-47	-48	-45	n.a.	n.a.
50,001 to 75,000	-45	n.a.	n.a.	n.a.	n.a.
75,001 to 100,000	n.a.	n.a.	n.a.	n.a.	n.a.
100,001 to 500,000	0 ^a	n.a.	n.a.	n.a.	n.a.
500,001 to 1,000,000	n.a.	n.a.	n.a.	n.a.	n.a.
Over 1,000,000	n.a.	n.a.	n.a.	n.a.	n.a.

SOURCE: Congressional Budget Office based on data from Environmental Protection Agency, *Regulatory Impact Analysis of Proposed National Primary Drinking Water Regulations for Radionuclides* (April 1991), and an assumed value of \$10 million per cancer case avoided.

NOTE: n.a. = not applicable because no systems fall into this combined size and concentration category.

a. The combination of the size of the system and the initial concentration had a positive net benefit of \$2.00. CBO initially assumed that systems with positive net benefits would undertake treatment without federal standards. Therefore, positive net benefits are not considered positive welfare effects that are brought about by the proposed standard.

Table 3.
Number of Systems Exceeding Concentration Levels for Adjusted Gross Alpha Emitters

Size of System (Number of people served)	Systems with a Concentration Level (Picocuries per Liter) of:						
	>15	>20	>25	>30	>35	>40	>45
25 to 100	42	21	11	7	5	3	2
101 to 500	26	14	7	4	3	2	1
501 to 1,000	21	12	7	4	3	2	2
1,001 to 3,300	19	10	6	4	3	2	1
3,301 to 10,000	5	3	2	1	1	1	0
10,001 to 25,000	6	3	3	2	1	1	1
25,001 to 50,000	2	1	1	0	0	0	0
50,001 to 75,000	1	0	0	0	0	0	0
75,001 to 100,000	0	0	0	0	0	0	0
100,001 to 500,000	1	0	0	0	0	0	0
500,001 to 1,000,000	0	0	0	0	0	0	0
Over 1,000,000	0	0	0	0	0	0	0
Total Number of Systems	123	64	37	22	16	11	7

SOURCE: Congressional Budget Office based on data on the presence of adjusted gross alpha emitters in drinking water systems from Environmental Protection Agency, *Regulatory Impact Analysis of Proposed National Primary Drinking Water Regulations for Radionuclides* (April 1991), and extrapolation from the National Inorganics and Radionuclides Survey to the population of community water systems.

NOTE: To calculate the welfare effects in Table 2, CBO assumed that each system was at the upper end of its concentration range. For example, systems that had concentrations greater than 15 but not greater than 20 were assumed to have a concentration of 20. That assumption yields an upper bound on the potential net benefits of treatment.

totaled. Positive net benefits are not included in that total. If one assumed that systems would not undertake any treatment without federal standards, then one would include positive net benefits. The magnitude of positive net benefits are so small, however, that the estimate of total welfare losses would still be \$12 million.

The total cost of the proposed standard is estimated at \$19 million annually.¹⁶ The welfare loss, therefore, is significant when compared with the cost of achieving the standard.

What Is the Relevance for Other Drinking Water Standards? The above analysis shows that uniform national standards may impose large welfare losses on some drinking water systems and the households that

they serve. The total welfare loss from the adjusted gross alpha standard is limited by the small number of households served by systems that violate the proposed standard. Adjusted gross alpha emitters are found primarily in drinking water systems that use groundwater. Groundwater systems tend to serve a relatively small number of households. Because adjusted gross alpha emitters are not found in surface water systems, the proposed standard does not tend to affect large systems.

How relevant is the analysis of adjusted gross alpha emitters to other drinking water standards? Three different factors are pertinent. In order of decreasing importance, they are:

- o The key factor creating welfare losses under the proposed standard for adjusted gross alpha emitters—that is, economies of scale in treatment—is not unique to treatments to achieve that standard.
- o The welfare losses that households served by small and medium-sized systems experience under the

16. The EPA estimated a total annual cost of \$37 million. This study's cost estimate is substantially lower than EPA's because it assumes systems would remove only as much of the contaminant as required to meet the proposed standard. The EPA's estimate of the cost of the rule assumes that each system will treat all of its water and, therefore, remove more of the contaminant than required to meet the standard.

proposed standard would be unaltered if more large systems were affected.

- o Several other contaminants primarily affect small and medium-sized drinking water systems.

The most important consideration is the role that economies of scale play in creating welfare losses. The EPA has examined the average per-household cost of treatment for systems under existing drinking water standards, based on the number of treatments they require (see Table 5). It found that for any given number of treatments required, the average per-household cost is much higher for small systems than for large systems. For example, the average per-household cost of installing and operating one treatment is \$577 for a surface water system in the smallest category (25 to 100 people). However, the average per-household cost is only \$4 when a system in the largest category (more than 1 million people) requires one treatment. On the other hand, the per-household benefits of meeting a given standard do not change according to the size of

the system. Economies of scale mean that standards that are justified for large drinking water systems will often impose welfare losses on small systems.

A striking result of the analysis of adjusted gross alpha emitters is that only one system experiences positive net benefits from meeting the standard. If that pollutant was also found in surface water systems, more systems would experience positive net benefits as a result of meeting the standard. Consequently, the standard would appear more favorable based on an analysis of total costs and benefits. However, it would not affect per-household welfare losses. Specifically, the welfare losses of households served by small and medium-sized systems would not diminish if the standard affected more large systems. Whether total welfare losses for all systems would be affected or not depends on the method used to calculate them. Total welfare losses would not be affected if one assumed that communities would choose efficient standards even without federal requirements. However, total welfare losses would be reduced (and might be completely off-

Table 4.
Number of Households Exceeding Concentration Levels for Adjusted Gross Alpha Emitters

Size of System (Number of people served)	Households with a Concentration Level (Picocuries per Liter) of:						
	>15	>20	>25	>30	>35	>40	>45
25 to 100	873	436	229	145	94	64	45
101 to 500	2,348	1,264	632	397	258	175	124
501 to 1,000	6,596	3,628	2,309	1,339	912	648	476
1,001 to 3,300	16,345	8,172	4,903	3,395	2,312	1,644	1,208
3,301 to 10,000	15,198	7,599	5,066	3,396	2,273	1,592	1,155
10,001 to 25,000	49,632	28,361	21,271	15,224	11,277	8,640	6,801
25,001 to 50,000	52,230	34,820	34,820	0	0	0	0
50,001 to 75,000	35,769	0	0	0	0	0	0
75,001 to 100,000	0	0	0	0	0	0	0
100,001 to 500,000	100,345	0	0	0	0	0	0
500,001 to 1,000,000	0	0	0	0	0	0	0
Over 1,000,000	0	0	0	0	0	0	0
Total Number of Households	279,336	84,280	69,230	23,896	17,126	12,763	9,809

SOURCE: Congressional Budget Office based on data in Table 2, Environmental Protection Agency data on average population per system, and an assumption of 2.7 people per household.

Table 5.
Average Cost per Household for Monitoring and Compliance, by Size of System
and Number of Treatments (In 1992 dollars)

Size of System (Number of people served)	Groundwater Treatments				Surface Water Treatments			
	Zero ^a	One	Two	Three	Zero ^a	One	Two	Three
25 to 100	171	338	984	1,194	171	577	1,087	2,402
101 to 500	45	91	337	437	45	291	467	1,009
501 to 1,000	18	39	144	189	18	340	225	458
1,001 to 3,300	8	21	84	n.a.	9	22	130	306
3,301 to 10,000	4	16	50	n.a.	4	33	90	188
10,001 to 25,000	2	13	38	n.a.	2	30	42	143
25,001 to 50,000	1	8	n.a.	n.a.	1	19	31	50
50,001 to 75,000	1	5	n.a.	n.a.	1	5	21	84
75,001 to 100,000	1	4	n.a.	n.a.	1	13	24	n.a.
100,001 to 500,000	b	4	n.a.	n.a.	b	12	27	154
500,001 to 1,000,000	b	3	n.a.	n.a.	b	5	10	n.a.
Over 1,000,000	n.a.	n.a.	n.a.	n.a.	b	4	9	n.a.

SOURCE: Congressional Budget Office based on data from the Environmental Protection Agency.

NOTE: n.a. = not applicable because no systems fall into this category.

a. Costs in this case represent monitoring costs only.

b. Less than \$1.00.

set by welfare gains) if one assumed that without federal requirements, communities would not undertake any treatment.

Like adjusted gross alpha emitters, many drinking water contaminants are found primarily in groundwater systems. As with the standard for adjusted gross alpha emitters, therefore, standards for those contaminants are expected to affect primarily small and medium-sized drinking water systems. One study reports information on 81 contaminants that the EPA either currently regulates or for which it has proposed regulations. Twenty-one of those contaminants (including adjusted gross alpha emitters) are expected to be found primarily in groundwater systems.¹⁷

Such factors reveal that the problem of welfare losses under uniform standards is not likely to be unique to the proposed standard analyzed in this study. The magnitude of total welfare losses from other stan-

dards will, of course, vary depending on the unique features of those standards.

The total welfare losses from uniform standards for some contaminants could be much larger than those from the standard for adjusted gross alpha emitters. Greater losses are particularly likely when the standard affects many households and is costly to meet. For example, the EPA estimates that the ultimate cost of meeting its proposed standard for disinfectants and disinfection by-products (DBP) is \$2.6 billion—more than the cost of all existing drinking water standards combined.¹⁸ That rule would require systems to replace current methods of disinfection with more expensive methods. The rule stems from a concern that current methods may create cancer-causing by-products.

The EPA expects the annual household cost of complying with the rule to range from less than \$10 (primarily for large surface water systems) to as much

17. RCG/Hagler Bailly, *An Evaluation of the Federal Drinking Water Regulatory Program Under the Safe Drinking Water Act as Amended in 1986* (report prepared for the American Water Works Association, Washington, D.C., August 11, 1993), Appendix A.

18. Environmental Protection Agency, *Regulatory Impact Analysis of Proposed National Primary Drinking Water Regulations: Disinfectants/Disinfection By-Products* (May 1994), p. 5-7.

as \$350 (for small ground water systems).¹⁹ But the size of the benefits that might result from the rule is highly uncertain. The EPA currently estimates that the average cost per cancer case avoided under the proposed standard could be as low as \$512,000 or as high as \$12.8 billion.²⁰ Given the high cost of complying with the DBP requirements, the economies of scale in treatment, and the uncertainty about the benefits, that standard could result in significant total welfare losses. Furthermore, the 1996 amendments explicitly prohibit the cost-benefit criterion from being applied to that standard.²¹

Welfare losses from uniform standards for some contaminants could also be less than those resulting from meeting the standard for adjusted gross alpha emitters. In some cases, the standard may not result in any welfare losses. For example, the EPA has proposed a standard for radon 222. Based on the EPA data, the cost per cancer case avoided under that standard is expected to be \$5 million or less—even for small systems.²² All water systems will therefore have positive net benefits when they meet the standard.

The Possible Impact of the 1996 Amendments on Welfare Losses. The 1996 amendments to the Safe Drinking Water Act could considerably reduce—but not eliminate—the welfare losses from uniform national drinking water standards. That reduction could occur in three ways.

First, as described above, the amendments allow the EPA to consider costs and benefits when setting a maximum contaminant level. Using that cost-benefit criterion may lower total welfare losses and welfare losses to large systems. It will not, however, eliminate the potential for small systems to incur substantial welfare losses. A standard that passes a total cost-benefit test may impose significant welfare losses on small sys-

tems as a result of the economies of scale in treating drinking water.

Second, the 1996 amendments may reduce welfare losses by encouraging the use of less conventional—and lower-cost—technologies. If the amendments make it easier for small systems to use less-conventional technologies, the amendments will cut welfare losses.

Third, the 1996 amendments may also reduce the welfare losses from federal standards by allowing some systems not to meet them. Widespread use of the variance technologies defined in the 1996 amendments could reduce, but would not eliminate, welfare losses for small systems. They could not eliminate them because the EPA is directed to use an affordability criterion in defining them rather than a cost-benefit criterion. Treatments deemed affordable to small systems may not be justified on the grounds of costs and benefits. In some cases, no treatment—not even the use of a variance technology—may be the efficient solution for small systems. In addition, the EPA and the states must overcome many hurdles to further the widespread use of variance technologies. Those hurdles include developing accepted definitions of what is "affordable" and what adequately protects public health.

Deciding on the Methods of Treatment

Considerations of information highlight the importance of making the choice about controls at the lowest level possible. For drinking water, allowing individual systems to select their own method of meeting the standard is generally most efficient. The least-cost method of meeting a standard will vary among public water systems based on a variety of factors. Those factors include the size of the system, the initial level of contamination, and the existing equipment that the system has in place. Decentralizing the selection of the method of control will best reflect such varying factors.

Centralizing the selection of the method of control is efficient under some circumstances. Under those circumstances, centralization has advantages that outweigh the advantages of information that accrue when the selection is decentralized. Those circumstances do

19. Ibid., exhibits 5-3 and 5-4.

20. Ibid., p. 5-7.

21. U.S. House of Representatives, *Safe Drinking Water Act Amendments of 1996*, section 104.

22. The American Water Works Association estimates that the treatment costs will be much higher than those estimated by the Environmental Protection Agency. The EPA estimates that the total annual cost of complying with the proposed radon standard will be \$280 million. The AWWA estimates that the cost will be over \$1.9 billion. See Congressional Budget Office, *The Safe Drinking Water Act*, p. 11.

not, however, generally apply to selecting methods of treating drinking water. For example, the choice of treatment that a given water system makes does not impose costs or benefits on people outside the system, nor does it affect the treatment costs that other systems face. Considerations of externalities, therefore, do not warrant a centralized selection process.

In theory, water systems have a great deal of flexibility to choose the least-cost method to meet a standard. In reality, however, the need to obtain state approval may considerably constrain their choices. At least in some cases, states have been reluctant to approve the use of less-conventional, lower-cost technologies because of concerns about their effectiveness. Several initiatives are under way to address that problem. If successful, those initiatives should increase the variety of control options from which systems might choose.

The Current Process of Selecting a Method of Treatment

In theory, systems have a considerable amount of latitude in choosing their method of meeting a given standard. The EPA defines the standard as a concentration level—for example, picocuries per liter. The EPA judges compliance on whether systems achieve the defined concentration level, not on whether they have used a specific technology.

Because water systems need to obtain state approval of the control technology they use, the amount of latitude they have in choosing technologies is limited.²³ States see that approval as necessary to ensure that the technology for treatment is properly engineered to bring water systems into compliance.

Frequently, states are reluctant to approve the use of less-conventional technologies. That reluctance restricts systems from using alternative technologies that may allow them to meet the standard at a lower cost. Small systems, which typically experience much higher per-household treatment costs than large systems, have

found that particularly difficult. The reluctance of states to approve the use of less-conventional technologies has its roots in several concerns—the reliability of those technologies, the likelihood that the vendors that provide them will still exist in the future should problems arise, and the ability of systems (particularly small systems) to understand and operate those technologies effectively. Although those concerns are valid, most experts agree that water systems would benefit from a streamlined approval process and an increase in the variety of control options from which they might choose.

In addition, some states are reluctant to approve the use of a particular brand name if it has not previously been used in the state. They may be reluctant even when the EPA defines that technology as an appropriate one and it has been used effectively in other states. Sometimes vendors have had to repeat pilot tests in multiple states to obtain state approval of their product. In fact, vendors have had to repeat pilot tests in different districts of the same state. Such concerns of the states have led to unnecessary duplication of tests in some instances. In other cases, however, the specific conditions that affect a system's performance (for example, water temperature, pH level, or the extent of contamination) may vary from one area to another, and multiple tests have therefore been necessary.

Solutions to Existing Problems

The 1996 amendments include several provisions designed to address the problems described above. First, the amendments require the Environmental Protection Agency to define technologies that achieve compliance with the standard for four different categories of system size. Historically, the EPA defined such technologies for large systems only. The 1996 amendments now require the EPA to identify available technologies that both meet the maximum contaminant level and are affordable for three additional categories of system size. Those categories range from systems serving a population of 25 to systems serving a population of 10,000.²⁴ In addition, the 1996 amendments allow the EPA to update the list of feasible and affordable technologies

23. The observations in this section are based on discussions with the staff of the Environmental Protection Agency, representatives of the Association of State Drinking Water Administrators, and representatives of the Water Quality Association (an association of vendors of equipment for treating drinking water).

24. U.S. House of Representatives, *Safe Drinking Water Act Amendments of 1996*, section 105, p. 14.

as new or innovative treatment technologies become available.

Second, the EPA must include packaged or modular systems in its list of feasible technologies.²⁵ Those systems are off-the-shelf treatment units that water systems may install. They are typically less costly than custom-designed treatment methods and have the potential to greatly lower compliance costs for small systems. Historically, however, states have been reluctant to approve the use of those technologies.

In addition, the 1996 amendments direct the EPA to include point-of-entry and point-of-use treatment units in their list of feasible technologies. Those units treat only a portion of the water. For example, units that remove lead may be installed on kitchen and bathroom sinks. Those treatment methods may yield considerable cost savings because they allow a large share of the water to go untreated. In addition, they can avoid the costly replacement of underground pipes. However, before the 1996 amendments, EPA regulations prohibited states from approving the use of point-of-entry and point-of-use devices except under very special circumstances.

Finally, the 1996 amendments require the EPA to be more specific about the conditions under which identified technologies will achieve a given standard. For example, the EPA must consider how the quality of the source water will affect the performance of a given technology.²⁶ That increased specificity is expected to streamline the process for state approval of technologies.

Determining and Funding the Basic Research Agenda

Developing effective drinking water standards requires many different types of research such as compiling information on the various contaminants found in water systems, assessing the effects on health from those contaminants, and determining the cost-effectiveness of

alternate technologies to remove the contaminants. Each of those endeavors may entail resolving complex analytic questions. For example, a lack of reliable detection techniques hampers efforts to determine the presence of the pathogen *cryptosporidium*. That pathogen led to the 1993 outbreak of gastroenteritis in Milwaukee, Wisconsin. In addition, detecting the health effects from contaminants might involve conducting animal studies, which would then pose the problem of extrapolating findings to humans.

Research is most efficiently determined and funded at the federal level when its results will benefit many states. States' decisions about research are most efficient when the research addresses problems that are unique to that state. Finally, cooperation in research efforts between the public and private sectors is efficient when both sectors can benefit from the results. The existing allocation of responsibility for conducting research on drinking water is generally consistent with those guidelines.

A Strong Federal Role

Most drinking water contaminants are found in many states. As such, it is most efficient for the federal government to determine and fund research on their health effects. Those research results are "public goods" that can simultaneously benefit multiple states. The federal government can provide those results to additional states at very little cost. No individual state on its own would have an incentive to devote enough resources to that type of research. Each state has an incentive to balance the cost of the research against its own expected benefits rather than the benefits that all states would receive.

The federal government has the primary responsibility for assessing the potential risks from most drinking water contaminants. In recent years, the EPA spent between \$19 million and \$25 million per year and devoted between 155 and 164 work-years to those efforts.²⁷ Researchers used those resources primarily to

25. *Ibid.*, p. 15.

26. *Ibid.*

27. The actual dollar values are \$21.6 million in 1996 (estimated) supported by 157.5 work-years, \$22.2 million in 1995 supported by 157.6 work-years, and \$19.5 million in 1994 supported by 163.3 work-years. The Environmental Protection Agency requested \$24.3 million for 1997 with 155.6 work-years. See Environmental Protec-

identify contaminants present in water systems and to evaluate the risks they pose to human health.

The EPA plans to spend its 1997 research funds on a variety of projects, including efforts to determine the potential health risks and human exposure to microbial pathogens, disinfection by-products, and arsenic. The EPA will also attempt to understand better the risks from pathogens, particularly viruses, in groundwater. In addition, research efforts will be directed at assessing and evaluating treatment processes and other means of reducing risks from microbial pathogens, arsenic, and by-products of disinfection or corrosion. Efforts to develop and evaluate treatment technologies focus mainly on small systems, which typically face very high per capita treatment costs compared with large systems.²⁸

States' Research Efforts

Research is most efficiently conducted by a single state when the problem addressed is unique to that state. New Jersey is the only state with a significant research program on drinking water. That program has an annual budget of approximately \$300,000 and has been in existence since 1985. New Jersey has used those funds to identify contaminants present in the state. It has also conducted research on methods of communicating risks to the public. Finally, it has explored how risks from mercury might be managed. Mercury has not typically been found in drinking water outside New Jersey.²⁹

Private and Public Cooperation in Research Efforts

Some types of private industry and the public sector sometimes share research goals, which is the case in research on drinking water. Federal funds augment the efforts of private industry to identify cost-effective methods for managing risks from drinking water contaminants. The American Water Works Association, an association of large, private drinking water facilities, conducts research on methods of treating drinking water through its research foundation, the American Water Works Research Association Foundation (AWWARF). AWWARF also conducts research on other aspects of water supply, planning, and operations. The Congress has earmarked money for the AWWARF since 1992.³⁰ In recent years, the AWWARF has had a budget of approximately \$11 million, with the Congress providing \$2.5 million and members contributing the remainder. The AWWARF undertakes some research jointly with the EPA. For example, since fiscal year 1994, the AWWARF has invested \$8.6 million in cooperative agreements with the EPA.³¹

Furthermore, in fiscal years 1996 and 1997, the Congress earmarked \$1 million per year for a joint research effort by the EPA and AWWARF. The research was directed at understanding the health effects of arsenic. The EPA is considering lowering the existing standard for arsenic. The earmarked funds are to help identify the health benefits that might result from making the standard more stringent. In addition, an association of utilities in California has joined in the joint EPA/AWWARF effort to determine the health effects of arsenic. Increasing the stringency of the arsenic standard could be extremely expensive for California. Thus, California water utilities are particularly interested in whether those costs are warranted.

tion Agency, *Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1996*, EPA 205-R-95-001 (February 1995), p. 5-12, and *Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1997*, EPA 205-R-96-001 (March 1996), p. 3-23.

28. Environmental Protection Agency, *Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1997*, pp. 3-23 to 3-26.

29. Information provided to the Congressional Budget Office by Leslie McGeorge, Director of the Division of Science and Research, New Jersey Department of Environmental Protection.

30. The Congress also earmarked \$1 million per year for the American Water Works Association Research Foundation in 1984, 1985, and 1986. The objective of those funds was to initiate a research program. The funds were matched by AWWA members. (Personal communication to the Congressional Budget Office by Rick Karlan, AWWARF, November 13, 1996.)

31. American Water Works Association Research Foundation, *Congress and the Drinking Water Community: Partners in Progress and Scientific Advancement* (Denver, Colo.: August 1996).

Case Study of Ground-Level Ozone Control

Ground-level ozone, a key ingredient in smog, has a significant impact on human health. National legislative efforts to control ozone date from 1955. The Clean Air Act (CAA) amendments of 1970, 1977, and 1990 are the most recent pieces of legislation to address that pollution problem. Those laws address questions of which level of government can most appropriately set standards, determine pollution-control methods, and expand the knowledge base.

The history of national air pollution legislation has involved an ever-increasing role for the federal government. Mounting concern about persistent problems of air quality and expanding scientific information about air pollution have accompanied that trend. Yet despite stiffer emission controls based on the severity of local problems, many areas still exceed the national ambient air-quality standard for ozone. To add to the problem, in the past two decades, increasing scientific understanding of the processes of ozone pollution has focused growing attention on the problem of the long-range movement of ozone pollutants between areas. That movement is referred to as the "transport" of ozone pollutants.

This chapter examines how standards are set, methods of control are selected, and research responsibilities to control ground-level ozone are assigned. In some instances, the division of responsibility among levels of government is consistent with the principles of economic efficiency, and in others it is not.

In the area of setting standards, the federal government does not always exercise its decisionmaking au-

thority in a manner that is likely to achieve maximum net benefits to society. A fundamental problem is that the basic approach of the CAA amendments of 1990 does not address the movement of ozone pollutants from area to area.

On the issue of selecting methods of control, the division of responsibility under the CAA does not always clearly correspond to one that would be most likely to provide the maximum net benefits to society. Except under special circumstances, selecting pollution-control methods is often most appropriately allocated to decentralized levels of government. The current CAA contains federal requirements for control measures. Although concerns about efficiency may justify those requirements in some cases, in others they may not.

Finally, the division of responsibility for research broadly corresponds to that which has the best chance of bringing the most net benefits to society. The federal government is the chief sponsor of research on ozone pollution and its effects on human health and the environment.

Background

Ground-level ozone makes an interesting case study for environmental federalism. It not only has significant effects on human health and the environment but is also a complex problem, and the role of the federal government in the control program has been increasing.

Effects of Ground-Level Ozone Pollution

Ground-level ozone pollution has a significant impact on the respiratory health of exposed populations. In addition, it harms crops, vegetation, soil, water, materials, and animals; it also impairs visibility. Effects on health are the primary concern at concentration levels typically occurring in the United States. The damaging effects on crops and vegetation are the second most important problem. Ozone interferes with the growth rate of plants, reducing crop yields and damaging the quality of crops such as corn, wheat, and soybeans. Ozone also reduces the ability of plants and trees to fight disease.

Analysts divide the adverse effects of ground-level ozone on respiratory health into three different categories. The first is interference with normal activity, especially for people with impaired respiratory systems. The second is episodic and incapacitating illnesses, including respiratory infections (pneumonia and asthma attacks) and exacerbation of diseases (bronchitis and emphysema). The third is progressive respiratory impairment and permanent injury—including possible death. Scientists have a better understanding of the causal relationship for some categories of effects than for others. For example, only indirect evidence exists for the most adverse health effect associated with ozone exposure—an increase in death rates.

Researchers identify the following population groups as sensitive to ozone exposure: active individuals, people with preexisting respiratory disease, children, and the elderly. Before July 18, 1997, the standard for ozone was a one-hour measurement of 0.12 parts per million (ppm). Areas could not exceed that ambient ozone concentration on more than three occasions in any three-year period. In July 1995, approximately 118 million people in the United States lived in areas where ozone concentrations violated the standard.¹

The American Lung Association estimates that about 3.5 million people are at risk from ozone because of chronic bronchitis and emphysema. Two million people are at risk because of adult asthma, and 1 mil-

lion because of pediatric asthma. The association also estimates that 13 million children and 7 million people over the age of 65 are at risk.²

The Environmental Protection Agency revised the standard for ozone on July 18, 1997. The new standard is an eight-hour standard set at 0.08 ppm. Areas are in compliance with the standard when the three-year average of the annual fourth-highest daily maximum eight-hour average ozone concentration is less than or equal to 0.08 ppm.³ Although areas are still required to meet the 0.12 ppm one-hour standard, each area will have to meet the new 0.08 ppm eight-hour average standard by 2010. Once an area is judged to be in compliance with the 0.12 ppm standard, that standard is revoked for that particular area. The area must then continue to make progress toward the new 0.08 ppm eight-hour standard.

The Formation of Ground-Level Ozone Pollution

Ground-level ozone results from a combination of emissions of two precursors in the presence of sunlight—nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Highway vehicles and utilities accounted for most man-made NO_x emissions in the United States in 1990. Area sources—small widespread facilities such as dry cleaners and bakeries—and highway vehicles accounted for most man-made VOC emissions in that same year.⁴ Reducing ground-level ozone pollution depends on controlling NO_x and VOC emissions.

The photochemical processes that create smog are complex. For example, the effect on ozone formation of controlling different precursors depends on the ratio of VOCs to NO_x in the air. If the ratio is high, controlling NO_x emissions will generally help to reduce ozone. Conversely, if the ratio is low, controlling VOCs will generally help to reduce ozone.

1. Environmental Protection Agency, *Areas Designated Nonattainment* (1995).

2. American Lung Association, *Out of Breath: Populations-at-Risk to Alternative Ozone Levels* (Washington, D.C.: ALA, 1995).

3. Environmental Protection Agency, "Final Rule: National Ambient Air Quality Standards for Ozone," *Federal Register*, vol. 62, no. 138 (July 18, 1997), p. 38859.

4. E.H. Pechan & Associates, Inc., *Ozone NAAQS Review Clean Air Act Base Case Evaluation for 2007: Draft Final Report* (Springfield, Va.: E.H. Pechan & Associates, 1994).

In addition, the complex physical and chemical processes that affect ozone are not yet fully understood. Meteorological factors such as high temperatures and stagnant air enhance the rate of ozone formation. High ozone levels spanning large areas are borne by high-pressure weather systems crossing the central and eastern United States—typically from west to east or northwest to southeast.⁵ The processes of cloud formation can either disperse or carry ozone and its precursors.⁶ Finally, the chemical production processes for ozone occur over varying periods. Scientists cannot clearly identify a fixed period in which climate or weather has an effect on ozone formation and the long-range movement of ozone pollutants.

The Federal Government Takes a Central Role

The first federal legislation on air pollution—the Air Pollution Control Act of 1955—declared that states and local governments had the primary responsibility for controlling air pollution. It defined the federal role as one of supporting research and providing technical services and financial aid to state and local government agencies. The Congress then began expanding the federal role, instituting the first federally required tailpipe emission controls with the Motor Vehicle Air Pollution Control Act of 1965. Under the Air Quality Act of 1967, the Congress tried to expand its catalytic role. It unsuccessfully instructed states to set ambient standards and devise plans to control emissions for selected geographic areas based on shared concerns about air quality.

With the CAA amendments of 1970, the federal role expanded significantly. The federal government took responsibility for determining geographically uniform standards for common air pollutants, including ozone. Taking action to limit opportunities for inter-jurisdictional competition for industry, the Congress also charged the federal government with establishing uniform new source performance standards for large stationary sources. For other stationary sources of

emissions, however, the states were still left with an enormous amount of discretion regarding air pollution control programs. States submitted state implementation plans (SIPs) for ozone control to the Environmental Protection Agency for approval. The SIPs outlined controls to be placed on state-selected emission sources in order to achieve the standard.

Through the CAA amendments of 1977, the Congress again expanded the federal role in the air-quality program. The amendments identified general categories of controls that states were specifically to address in their SIPs. The Congress also required states that were unable to meet the ozone standard by December 31, 1982, to "establish a specific schedule for implementing a vehicle inspection and maintenance program."⁷

The CAA amendments of 1990 significantly enlarged federal involvement. They were remarkable in two respects. First, federal legislators went to great lengths to reflect geographic variation in ozone concentrations when applying federal requirements. They defined requirements for emission control and attainment deadlines for areas according to their degree of severity in violating the standard—classifying metropolitan areas and counties as marginal, moderate, serious, severe, or extreme. Areas with more serious violations of the standard are now subject to more requirements for controlling pollutants, but they also have more time to comply with the standard.

Second, the Congress took action to address the effect of long-range movements of pollutants on air quality. The perception of the ozone problem during the 1960s and early 1970s was that smog was a local problem confined to certain urban airsheds. During the mid- to late-1970s, field measurements in the eastern United States began to show widespread areas of high ozone concentrations. Analysis of data from the eastern United States revealed "rivers of ozone" flowing over areas of 600 miles or more. The perception of ozone began to change from a purely local phenomenon to a widespread one with embedded local "hot spots,"

5. National Research Council, *Rethinking the Ozone Problem in Urban and Regional Air Pollution* (Washington, D.C.: National Academy Press, 1991).

6. Ibid.

7. Title I of the Clean Air Act Amendments of 1977, 42 U.S.C. 7502, 91 Stat. 748.

primarily in urban areas.⁸ With the 1990 amendments, the Congress created a regional authority, the Ozone Transport Commission, for the states of the Northeast to address violations of the standard associated with their entire region.

Choosing the Extent of Ozone Control

Which level of government can most appropriately set standards? Theoretically, it is the one with an incentive to choose the most efficient level of protection and with the best knowledge of underlying costs and benefits. The presence of "externalities" is the primary consideration in making the choice. Externalities are costs or benefits that extend beyond jurisdictional boundaries. In controlling ground-level ozone, externalities may play a relatively large role. Consequently, it makes sense to assign the setting of standards to a level of government that has jurisdiction over all affected areas. A second important consideration—information—points toward relying on regional organizations that can both address externalities and exploit knowledge of unique factors that affect costs and benefits. A final consideration is the potential for interjurisdictional competition to result in less-than-optimal environmental standards.

Evidence of long-range movement of ozone and its precursors has been growing. Recent assessments affirm that ozone is moving through the Northeast Corridor and that another airshed of concern covers much of the midwestern and eastern United States.⁹ Studies have documented widespread pollution passing from the Midwest and the Southeast to (and through) the

Northeast.¹⁰ Photochemical modeling simulations confirm that to achieve lower ozone in regions receiving imported pollutants, reducing ozone precursor emissions—especially NO_x emissions—from an upwind region would be necessary.¹¹

Given the movement of ozone pollutants, individual states and localities are unlikely to have the incentive to undertake sufficient levels of abatement. Theoretically, the federal government could maximize society's net benefits by assigning appropriate abatement efforts to different areas. In a world that had perfect information and was free of political constraints, a federal authority could easily accomplish that. In the real world, several factors preclude it. Scientists are unable to measure with complete accuracy the extent of the transport of ozone pollutants between areas. Also, episodes of high ozone concentrations in a given area may be linked to different patterns of transport. In addition, assessing the magnitude of the benefits from reducing ozone can be difficult.

Lower levels of government also face those difficulties, but they may have more detailed information about the costs of employing controls locally as well as the benefits to their constituents based on local preferences. Potentially then, creating regional authorities to determine the appropriate extent of environmental protection could be more efficient. Another related option is to pursue negotiated agreements among states. In evaluating those alternatives, considering the associated transaction costs is essential.

Because emission controls affect many industries, interjurisdictional competition could result in less-than-optimal levels of environmental protection. However, empirical evidence is lacking on the extent to which states choose less-than-optimal standards to attract industry. Nor is there an unchallenged theoretical basis on which to argue that states do so. Under such cir-

8. Environmental Protection Agency, North American Research Strategy for Tropospheric Ozone, *NARSTO Research Strategy and Charter* (November 1994); G.T. Wolff and others, "An Investigation of Long-Range Transport of Ozone Across the Midwestern and Eastern United States," *Atmospheric Environment*, vol. 11 (1977), pp. 797-802; and J.F. Clarke and J.K.S. Ching, "Aircraft Observations of Regional Transport of Ozone in the Northeastern United States," *Atmospheric Environment*, vol. 17 (1983), pp. 1703-1712.

9. National Research Council, *Rethinking the Ozone Problem*; and P.S. Porter and others, *Statistical Characteristics of Spectrally-Decomposed Ambient Ozone Time Series Data* (prepared for the Environmental Protection Agency, Ozone Transport Assessment Group, August 1996).

10. Environmental Protection Agency, *NARSTO Research Strategy and Charter*; Paul Wishinski and Richard Poirot, "Air Trajectory Residence Time Analysis Investigation of Ozone Transport Pathways 1989-95" (summary draft, state of Vermont, February 20, 1995); Bret Schichtel and Rudolf Husar, "Source Regions of Influence for High and Low Ozone Conditions in the Eastern U.S." (summary draft, Washington University, St. Louis, Mo., August 8, 1996).

11. Ozone Transport Assessment Group, "Air Quality Analysis Workgroup and Regional and Urban Scale Modeling Workgroup, Joint Assessment of Transport" (preliminary draft of White Paper, Washington, D.C., September 1996).

cumstances, interjurisdictional considerations themselves do not provide a compelling reason for setting standards for ground-level ozone at the federal or regional level.

The Presence of Externalities: The Long-Range Movement of Ozone Pollutants

The Congress directed the EPA to set a standard for ozone that protects human health with an adequate margin of safety. Those instructions reflect the importance that the Congress places on providing a uniform minimum level of protection for human health. If the benefits from achieving that goal are high enough to justify the costs that go with it, the standard may increase the net benefits to society.¹² Dealing more effectively with the movement of ozone pollutants, however, could reduce the nation's cost of achieving the ozone standard. So far, the federal government has not fully capitalized on the appropriate role for a centralized authority to address that problem.

Under the basic framework of the CAA amendments of 1990, an area's requirements for abatement increase in stringency according to the severity of its violation of the one-hour standard (see Table 6). States must include in their SIPs the appropriate required controls for each area in their jurisdiction. The 1990 amendments require the EPA to apply one of two sanctions within 18 months of a state's failure to submit or take action on an adequate SIP. If the state does not correct the violation within six more months, the EPA must put the remaining sanction into effect. Finally, the CAA amendments require the EPA Administrator to issue a federal implementation plan within two years of finding an uncorrected state failure.

Given the contribution of long-range movement of ozone pollutants to the problem of not achieving the standard, the general framework of the Clean Air Act as amended in 1990 does not fully capitalize on the federal government's ability to deal with externalities. The abatement effort required of a given area depends on

the degree to which it violates the one-hour standard, not on the degree to which it emits pollutants that move to other areas. Alternatively, areas emitting pollutants that are likely to move to other areas may be required to make additional abatement efforts, even if they are attaining the ozone standard. In effect, they would need to meet a more stringent standard.

Although the CAA, as amended in 1990, includes provisions to deal with that issue, those provisions have not yet resulted in an adequate accounting for the transport of ozone and its precursors. Section 110 of the CAA stipulates that states' plans for controlling emissions must contain provisions preventing emissions that "contribute significantly" to nonattainment problems or that interfere with maintaining air-quality standards in downwind states.¹³ Congress did not, however, indicate how "contribute significantly" should be defined. The EPA is trying to use this section of the CAA to deal more effectively with the problem of transport and has proposed that 22 states and the District of Columbia reduce statewide emissions of NO_x in order to reduce problems that downwind states have in meeting the standard.¹⁴ The EPA plans to enact a final rule by September 1998.

Section 126 of the CAA allows states to petition the EPA for a finding that emissions from any major source or group of stationary sources in an upwind state contribute significantly to nonattainment in a downwind state.¹⁵ If the EPA makes such a finding, it will impose limits on the affected source or group of sources. The EPA has received petitions based on section 126 from eight states.¹⁶ It has not, however, determined whether upwind reductions will be required as a result of those petitions.

The Congress and the EPA have also initiated regional organizations through which states might ad-

12. As described in Chapter 1, that outcome may depend in part on the value of a safety-concern externality. When the value is sufficiently high and is applied to all communities, it can bolster the argument that a minimum federal standard improves national social welfare.

13. Section 110 of the Clean Air Act, 42 U.S.C. 7410(a)(2)(D), 91 Stat. 724.

14. Environmental Protection Agency, "Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone," *Federal Register*, vol. 62, no. 216 (November 7, 1997), pp. 60318-60421.

15. Section 126 of the Clean Air Act, 42 U.S.C. 7426(b), 104 Stat. 2404.

16. Environmental Protection Agency, "Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region," p. 60329.

Table 6.
Requirements and Deadlines Under the 1990 Amendments to the Clean Air Act

Nonattainment Category	Requirements	Deadline
Marginal	Submit inventory of emission sources with updates every three years Emission offsets for new major stationary sources: 1.1 to 1 Reasonable available control technology for major stationary sources of volatile organic compounds as required before 1990	November 15, 1993
Moderate	Meet requirements for marginal areas Emission offsets for new major stationary sources: 1.15 to 1 Reasonable available control technology for all major stationary sources of volatile organic compounds and nitrogen oxides Reduce emissions of volatile organic compounds by 15 percent over six years Basic vehicle inspection and maintenance program in urbanized areas Vapor recovery at gas stations selling over 10,000 gallons per month	November 15, 1996
Serious	Meet requirements for moderate areas Reduce definition of major stationary source to 50 tons Emission offsets for new major stationary sources: 1.2 to 1 Reduce volatile organic compounds by 3 percent annually in years seven to nine ^a Enhanced vehicle inspection and maintenance program in urbanized areas Improve monitoring Require specified percentage of fleet vehicles to use clean alternative fuels ^b Adopt transportation control measures if travels exceed expectations Contingency measures if milestones for emission reduction are not met	November 15, 1999
Severe	Meet requirements for serious areas Reduce definition of major stationary source to 25 tons Emission offsets for new major stationary sources: 1.3 to 1 Adopt specified transportation control measures Implement reformulated gasoline program Place a penalty of \$5,000 per ton on major sources that fail to meet required reductions	November 15, 2005 or November 15, 2007
Extreme	Meet requirements for severe areas Reduce definition of major stationary source to 10 tons Emission offsets for new major stationary sources: 1.5 to 1 Clean fuel or advanced controls on boilers emitting over 25 tons of nitrogen oxides per year	November 15, 2015

SOURCE: Congressional Budget Office based on Martin R. Lee, *Summaries of Environmental Laws Administered by the Environmental Protection Agency*, CRS Report for Congress 95-59 ENR (Congressional Research Service, January 3, 1995).

- a. The requirement could be satisfied by substituting a reduction in nitrogen oxide emissions for some or all of the reductions in volatile organic compounds after demonstrating that reducing nitrogen oxides would be as effective as reducing volatile organic compounds. The requirement can also be waived if the state demonstrates that its implementation plan includes all measures that can feasibly be carried out in light of available technology.
- b. Or equivalent measures not otherwise required by the Clean Air Act.

dress ozone transport. The strengths and weaknesses of those regional organizations are described below.

Information

Regional organizations may have an advantage over the federal government in setting standards because they are in a better position to exploit information on the unique factors affecting costs and benefits. They also face additional challenges.

Addressing Externalities Through Regional Authorities: The Ozone Transport Region. Growing evidence about the transport of ozone pollutants prompted the Congress to create a regional authority designed to deal with it. The 1990 Clean Air Act amendments created the Ozone Transport Region (OTR) for the Northeast. That region comprises Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont, in addition to Northern Virginia, and the District of Columbia. Its decisionmaking body, the Ozone Transport Commission, consists of one representative from each of the 12 member states, whom the governor appoints, and one from the District of Columbia. The commission has the authority to assess the degree of interstate movement of ozone pollutants and, on a majority vote, recommend strategies to the Environmental Protection Agency for addressing violations of the standard. The proposed controls could be applicable within all or part of the OTR as long as the commission decides that they are necessary to attain the standard anywhere in the region.

The Environmental Protection Agency may approve those recommendations, finding that the implementation plans of the states in the OTR are inadequate because they contribute to violations of the standard in other states. If the EPA approves the recommendations, each such state—whether or not it was part of the majority—must "include the approved additional control measures" in a revised SIP.¹⁷ The Ozone Transport Commission so recommended, and the EPA approved, adopting California's Low-Emission Vehicle (LEV)

program.¹⁸ In addition, states in the Ozone Transport Region have agreed to work within their own regulatory processes to establish specified NO_x emission limits for power plants and other large sources of fuel combustion. Thus, those states under the Ozone Transport Commission have operated as a regional authority, as well as a forum for negotiated agreements, in developing ways to address externalities linked to the movement of ozone pollutants from one area to another (see Box 3).

Both the Ozone Transport Commission's Low-Emission Vehicle program and the NO_x agreements have desirable characteristics. They are nonuniform measures that can reflect underlying differences in control costs within the OTR and address the movement of ozone pollutants between areas. In principle, under the EPA's rule for the commission's LEV program, states can adopt either California's LEV or any other measures necessary to achieve equivalent reductions in emissions.

The Ozone Transport Commission has tailored its NO_x agreement, with zone-by-zone variation in required emission reductions, to account for the direction in which ozone is most frequently transported. Further, the intent to carry out the plan through a trading mechanism capitalizes on other potential gains in efficiency.¹⁹ Sources that require costly reductions in emissions may comply with abatement requirements by purchasing pollution allowances from sources that can reduce emissions at less expense. The nonuniformity characteriz-

17. Title I, subpart 2 of the Clean Air Act Amendments of 1990, 42 U.S.C. 7511c(c)(5), 104 Stat. 2450.

18. The agency's rule required states in the Ozone Transport Region to adopt the commission's Low-Emission Vehicle program or to participate in a nationwide LEV program, should all automakers choose such a program. A third option was that "as an alternative to achieving emission reductions from new motor vehicles," states could adopt measures to prevent adverse effects on downwind areas. See Environmental Protection Agency, "Low-Emission Vehicle Program for the Northeast Ozone Transport Region," *Federal Register*, vol. 60, no. 15 (January 14, 1995), pp. 4712-4739. A March 11, 1997, ruling by a federal appeals court has raised questions about the ability of the EPA to compel states to comply with more restrictive emission standards for motor vehicles before 2004. See *Commonwealth of Virginia, et al. v. Environmental Protection Agency*, 108 F.3d 1397 (U.S. App. 1997). Also see Bureau of National Affairs, *Environment Reporter*, vol. 27, no. 44 (March 14, 1997), pp. 2230-2231.

19. Northeast States for Coordinated Air Use Management/Mid-Atlantic Air Management Association, *NO_x Budget Model Rule* (Boston, Mass.: NESCAUM/MARAMA, January 31, 1996). A preliminary analysis by the Environmental Protection Agency suggests that in 2005, the savings in costs attributable to the program would be about 30 percent—or nearly \$80 million in annualized cost—relative to the costs from having each individual facility bear sole responsibility for meeting the applicable emission limits.

ing the Ozone Transport Commission's agreements may result because regional authorities are likely to be more aware of the variation in control costs and constituents' preferences than is the federal government. In spite of those accomplishments, however, the Ozone Transport Commission faces three principal challenges to its efforts to find more efficient, regional solutions to the ozone pollution problem.

First, whatever the proposed solution, the commission cannot alter the uniformity of the one-hour and eight-hour ozone standards and the prescriptive control requirements that are assigned based on the degree to which the area violates the one-hour standard. Areas that are not in compliance with that standard must act on federal control requirements regardless of whether

more cost-effective control options are available elsewhere in the region.

Second, the Ozone Transport Commission relies somewhat on its member states to accept the legitimacy of its role. Nevertheless, some states have challenged the commission's authority. For example, Virginia has been a petitioner in the U.S. District Court of Appeals, arguing that in forming the Ozone Transport Commission, the Congress violated the Constitution. Virginia also challenged the EPA's authority to require states to adopt the commission's Low-Emission Vehicle program. The state claimed that evidence regarding ozone pollution did not support the agency's demand for regionwide reductions in NO_x and VOCs. Maine petitioned the EPA to let certain areas in compliance with

Box 3.

The Ozone Transport Commission Agreements

The Ozone Transport Commission has successfully passed two regional initiatives. By majority vote in February 1994, the commission recommended to the Environmental Protection Agency (EPA) that the Ozone Transport Region (OTR) adopt California's Low-Emission Vehicle (LEV) program. The EPA approved the LEV program in a final rule issued in January 1995. Eleven of the 13 OTR states agreed to the second regional initiative. In September 1994, those states signed a memorandum of understanding on controlling nitrogen oxide (NO_x) emissions from power plants and other large fuel combustion sources.

Under the Ozone Transport Commission's LEV program, each automobile manufacturer has to comply with volatile organic compound (VOC) and NO_x emission standards that begin in 1999 and become stricter in successive years. When the EPA approved the LEV program, it also acknowledged the acceptability of an alternative in which automakers would establish a nationwide LEV program. Carrying out the alternative nationwide LEV program would occur "only if it is agreed to by the Ozone Transport Commission states and the auto manufacturers."¹ Auto manufacturers and the Ozone Transport Commission reached agreement on many aspects of the nationwide LEV program.²

The second regional initiative is the Ozone Transport Commission's NO_x Memorandum of Un-

derstanding. States have agreed to work within their individual regulatory processes to establish emission controls for power plants and other large boilers. The agreement divides the OTR into three subregions: an inner zone, an outer zone, and a northern zone. The control requirements take place in two phases—the first beginning in May 1999 and the second in May 2003. To account for the movement of ozone pollutants between areas, control requirements vary according to the zone in which sources are found. The Ozone Transport Commission will carry out those control requirements using a regionwide trading mechanism. Sources that require costly reductions in emissions may comply by purchasing pollution allowances from sources that can reduce emissions at less expense.

1. Environmental Protection Agency, "Proposed Rules: Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines, Voluntary Standards for Light-Duty Vehicles," *Federal Register*, vol. 60, no. 195 (October 10, 1995), p. 52735. The nationwide Low-Emission Vehicle program applies to all states except California, which is allowed to maintain its stricter LEV program.
2. Environmental Protection Agency, "Rules: Air Pollution Control; New Motor Vehicles and Engines; Low-Emission Vehicle Program; Light-Duty Vehicles; Voluntary Standards," *Federal Register*, vol. 62, no. 109 (June 6, 1997), pp. 31192-31270.

the standard opt out of the Ozone Transport Region. Those areas are ones that "clearly meet the statutory criterion of having no effect" on violations of the standard elsewhere.²⁰

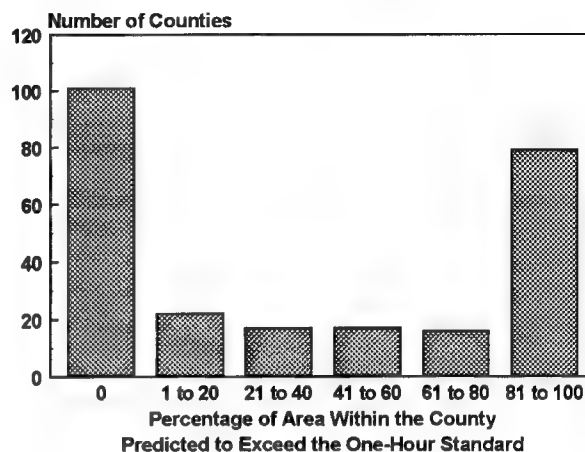
Third, even the additional control measures agreed on by the Ozone Transport Commission may not be sufficient to bring the region into compliance with the one-hour standard.

The Ozone Transport Commission's agreements, when applied along with the requirements of the 1990 amendments, do not necessarily succeed in bringing all areas of the region into compliance with the one-hour standard. The main problem is that the Ozone Transport Region is not large enough to address the full range of movement of ozone pollutants.

The EPA has used photochemical modeling to examine the impact that different scenarios to control emissions would have on the eastern United States. For those simulations, modelers often use meteorological data corresponding to a 15-day high-ozone episode in July 1988. One simulation examined the effect of having the Ozone Transport Commission's agreed-on controls in place during a similar 15-day episode.²¹ For the 252-county OTR, some portion of 151 different counties would exceed the one-hour standard under those conditions (see Figure 1).²² For 79 of those counties, 80 percent or more of their jurisdiction would be violating the standard.

Because of the long-range movement of ozone pollutants, gains in efficiency potentially accrue from obtaining additional emission reductions outside the OTR rather than within it. To illustrate that possibility, this study examined the total annual cost of three OTR states installing all feasible controls on NO_x emis-

Figure 1.
Number of Counties in the Ozone Transport Region Predicted to Exceed the One-Hour Standard When the 1990 Amendments to the Clean Air Act and Ozone Transport Commission Controls Are in Place



SOURCE: Congressional Budget Office based on data from the Environmental Protection Agency.

sions.²³ Feasible controls are those not yet explicitly required by the Clean Air Act or expected under the Ozone Transport Commission agreements. For a cost of \$111.7 million, those controls would reduce annual NO_x emissions by about 14,000 tons.

Next, this study examined the reductions obtainable if that same sum of money was spent for three states outside the OTR to install their most cost-effective remaining NO_x controls. (The remaining controls are those not yet explicitly required by the act.) Sources in those three states emit large amounts of NO_x and are generally upwind of the Ozone Transport Region.²⁴ In

20. Letter from Governor Angus S. King Jr. of Maine to Carol Browner, Administrator, Environmental Protection Agency, August 1, 1995.

21. The control strategies modeled to represent the Ozone Transport Commission agreements are a nationwide Low-Emission Vehicle program (for which emission reductions should be equivalent to the commission's LEV program) and a nitrogen oxide emission limit of 0.15 pounds per million (which is even more stringent than the commission's NO_x Memorandum of Understanding).

22. Note that the current standard allows for three hours of exceeding 0.12 parts per million over a three-year period. Under the conditions in the example used here, the counties would experience at least four hours of exceeding 0.12 parts per million over only a 15-day period.

23. The states chosen from the Ozone Transport Region were Connecticut, Massachusetts, and Rhode Island. Those states were selected by comparing projections of exposure of the population to maximum ozone concentration occurring across OTR states under the emission controls slated for adoption in the region. Connecticut, Massachusetts, and Rhode Island ranked first, second, and third.

24. The states chosen that were not from the Ozone Transport Region were Indiana, Ohio, and West Virginia. Those states were selected based on North American Electric Reliability Council (NERC) area designations and on data provided by the EPA, which identified the NERC region with the greatest NO_x emissions—the East Central Area Reliability Coordination Agreement (ECAR). Of the states in the ECAR region, those three were members of the group of states that accounted for over half of the utility-generated NO_x emissions outside the OTR.

Table 7.
Potential Gains in Efficiency from Reallocating Emission Reductions (In 1990 dollars)

Region	Total Annual Cost (Millions of dollars)	Total Annual Nitrogen Oxide Reductions (Tons)	Cost per Ton of Most Expensive Option (Dollars)	Average Cost per Ton (Dollars)
States in the Ozone Transport Region	111.7	14,012	410,000	7,900
States Not in the Ozone Transport Region	111.7	142,437	1,310	785

SOURCE: Congressional Budget Office based on data from the Incremental Control Measure Summaries Data System developed for the Environmental Protection Agency by E.H. Pechan & Associates, Inc., Springfield, Va., August 31, 1995.

that case, reductions in annual NO_x emissions would be about 142,000 tons (see Table 7). Therefore, one can purchase more than 10 times the emission reductions in the states outside the region.²⁵ The cost per ton of the most expensive non-OTR control option in the exercise is \$1,310, compared with \$410,000 for the most expensive OTR control option in the exercise. The average cost per ton of the non-OTR options is \$785, compared with \$7,900 for the average cost of the OTR options. Emission sources in the OTR are already subject to more stringent control requirements than sources outside the region, and that stringency explains the disparity in the cost-effectiveness of emission reductions among OTR and non-OTR states.

A significant limitation of the analysis is that the extent to which non-OTR NO_x reductions would lessen ozone concentrations within the OTR is unknown. The states selected are upwind of the OTR, but policy-makers would need to conduct more modeling to assess potential improvements in OTR ozone concentrations. The analysis does show, however, that wide variations occur in the cost of reducing NO_x emissions in different areas. Additional modeling that covered all of the locations that contribute to the movement of ozone pollutants could help determine which pattern of NO_x reductions would be the most cost-effective for bringing the OTR into attainment.

Addressing Externalities Through Negotiated Agreements: The Ozone Transport Assessment Group. The federal government has begun investigating the potential for state-level negotiations to achieve a more cost-effective solution to the ozone problem. A policy initiative by the EPA in early 1995 led to the formation of the Ozone Transport Assessment Group (OTAG). The OTAG partners included the Environmental Protection Agency, the Environmental Council of States, and various industry and environmental groups. The participants worked to reach consensus on addressing high ozone concentrations associated with the long-range movement of ozone pollutants across the midwestern and eastern United States.

The OTAG alleviated a key problem faced by the Ozone Transport Commission by more fully accounting for the potential range of movement of ozone pollutants. All states east of and including North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas were OTAG members. The OTAG process also had one major disadvantage when compared with the Ozone Transport Commission—the organization had no direct legislative authority and no decisionmaking rule. Its recommendations to the EPA were based on consensus and included minority viewpoints. In short, no legislative assurance existed that any OTAG recommendations would be fully considered in the EPA's policy-making process for establishing federally enforceable requirements. The OTAG's success in developing specific recommendations to be carried out therefore relied on the states' reaching consensus on acceptable strategies to control emissions.

25. The factor of 10 is a conservative estimate because the cost of controls used to comply with the Ozone Transport Commission's agreement on nitrogen oxides has recently declined by about half.

The OTAG faced two main obstacles in achieving a consensus on specific, efficient, regional strategies to address high ozone concentrations. First, the precise amount and geographic dimensions of the transport of ozone pollutants are uncertain and variable. Second, the many individual states involved in the process represented notably diverse views on the levels at which precursors should be controlled.

The strongest potential foundation for an OTAG agreement was a general scientific consensus on the dimensions and characteristics of the long-range movement of ozone pollutants. Simulations of photochemical models, performed under the auspices of the OTAG, attempted to examine the effects of precursor controls applied in four different OTAG zones (Northeast, Midwest, Southeast, and Southwest). Modelers found both regional and interregional benefits from reducing emissions. Those results imply three different scales for the movement of ozone pollutants: interzone, interstate,

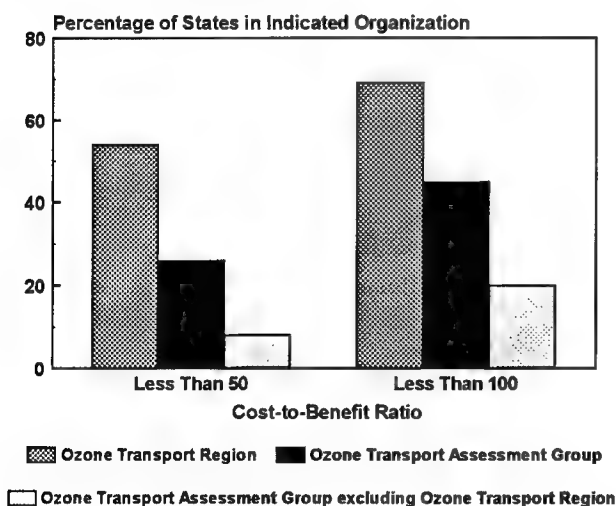
and intercity. Apparently, emission reductions in some zones are necessary to reduce ozone in others. Quantifying the culpability of a given source, however, remains a challenging task.

The diversity of interests among the 38 OTAG parties was greater than that reflected among the 13 states of the OTR. That greater diversity reduced incentives for cooperation and made it less likely that the group would achieve unanimity in voluntarily recommending specific levels of emission control. In particular, compared with the 13 OTR members, the 38 OTAG members had less to gain from agreeing to regionwide emission controls. Many non-OTR, OTAG members would have received relatively few of the benefits compared with the costs they would have borne from carrying out such controls. Thus, they had little to gain from cooperating with northeastern states.

To illustrate that point, for each organization, this study compared the costs and benefits of regionwide controls for each individual state. For each OTR state, those are the costs and benefits that would result if the OTR adopted the agreed-on Low-Emission Vehicle and NO_x emission-reduction programs. For each OTAG state, those are the costs and benefits that would result if the OTAG as a group adopted the same Low-Emission Vehicle and NO_x emission-reduction programs.²⁶ States with lower cost-to-benefit ratios have relatively more to gain from the emission-reduction programs than states with higher cost-to-benefit ratios. In addition, more variation in states' cost-to-benefit ratios within an organization suggests a greater diversity of interests and reduced incentives for cooperation (see Figure 2).

Cost-to-benefit ratios for the OTR states are generally lower and exhibit less variation than cost-to-benefit ratios for the OTAG states. Consider a cost-to-benefit ratio of 50 as a benchmark. How are states' cost-to-benefit ratios in each organization grouped with respect to that benchmark? Well over 50 percent of OTR

Figure 2.
Annual Cost-to-Benefit Ratio at the State Level
as a Result of Regionwide Emission Control
Programs (In 1990 dollars)



SOURCE: Congressional Budget Office based on modeling data on air quality and population from the Environmental Protection Agency and from the Incremental Control Measure Summaries Data System developed for the Environmental Protection Agency by E.H. Pechan & Associates, Inc., Springfield, Va., August 31, 1995.

NOTE: Costs are measured in dollar terms. Benefits represent reductions in ozone that are weighted by the number of people potentially exposed and the number of hours for which they are potentially exposed.

26. Costs are the annual costs of establishing the nationwide Low-Emission Vehicle program and a limit on nitrogen oxide emissions for major sources of 0.15 pounds per million Btus (British thermal units). Benefits are based on state-level, man-hour reductions in ozone—using the meteorology of the 1988 episode of high ozone levels in photochemical modeling simulations that reflect the same controls, as well as those prescribed by the 1990 amendments to the Clean Air Act. Reductions in man-hours are reductions in ozone that are weighted by the number of people exposed and the number of hours for which they are potentially exposed.

states have a cost-to-benefit ratio of less than 50. In contrast, only about 25 percent of the OTAG states have a cost-to-benefit ratio of less than 50. Next, consider a ratio of 100 as a benchmark. Almost 70 percent of OTR states have a cost-to-benefit ratio of less than 100, compared with only about 45 percent of the OTAG states. Thus, greater percentages of the OTAG states have relatively less to gain from entering into the type of regional agreements examined in this study.

The lack of incentives for cooperation within the OTAG, compared with the OTR, is even more pronounced when acknowledging that the Ozone Transport Commission achieved majority agreement on the specific controls examined here. Only 8 percent of the non-OTR, OTAG states have a cost-to-benefit ratio of less than 50, and only 20 percent have a cost-to-benefit ratio of less than 100. Finally, even if the OTAG negotiations ended with specific agreements on what each state would do to control emissions, policymakers would want to measure the gains from that outcome against the costs of those negotiations.

The greater the number of parties, the higher the transaction costs of negotiations are likely to be. Although estimating the transaction costs associated with the OTAG is beyond the scope of this study, they are likely to be significant. The OTAG involved over 700 participants, including individuals from the federal government, states, industry groups, and environmental groups. Over 30 meetings were held as part of the OTAG process. On average, each of those meetings involved between 200 and 250 people.²⁷ Most meetings were held for multiple days and required participants to travel to the meeting site. Furthermore, the OTAG issued numerous memorandums, reports, and working papers.

In June 1997, the OTAG voted on its final recommendations to the EPA. The consensus process led the group primarily toward untailored recommendations, endorsement of actions already being pursued, encouragement of voluntary control efforts, and suggestions for further study—including collaborative efforts between the EPA and the states. Even the more specific OTAG recommendations left responsibility to the EPA for assigning most state-by-state targets for reducing

NO_x emissions. The group exempted several states from the OTAG-related controls—namely, those that did not appear to be important sources for transported ozone pollutants. For the remaining states, the OTAG suggested targeting emissions from the utility sector within a range. It recommended that the lower bound of the range correspond to current requirements of the Clean Air Act (a 55 percent reduction from 1990 emission rates) and that the upper bound be an 85 percent reduction from 1990 emission rates. The group also recommended that the EPA establish state-by-state levels of control for large nonutility stationary sources in an equitable manner with controls on utilities.

Two of the OTAG's most important contributions have been its uniquely comprehensive technical analysis of the long-range movement of ozone pollutants and the information it has provided on state and stakeholder preferences.²⁸ Whether the overall OTAG process will be considered a success depends on several factors. Those factors include the extent to which the group's recommendations and analysis further the development of effective regulations to deal with the long-range movement of ozone pollutants. The EPA used the OTAG's modeling results in developing its proposed rule for reducing NO_x emissions in 22 states and the District of Columbia. It remains to be seen whether the OTAG's process facilitates the effective implementation of those reductions. In addition, any assessment of the group's success should weigh its unique accomplishments against the cost of the negotiations.

Interjurisdictional Competition

Externalities are the primary consideration in determining the level of government most likely to choose ozone standards that achieve maximum net benefits to society. Considerations of information also have an important impact. Indeed, policymakers are paying increased attention to both factors. A third consideration—concern about interjurisdictional competition—has already had a demonstrable influence on policymaking for ozone. That concern led the Congress to establish minimum standards for new stationary sources. Because of significant relocation costs, environmental regulations are

27. Personal communication to the Congressional Budget Office by Lauren Hassel, Walcoff & Associates, Arlington, Va.

28. The federal government may have limited knowledge of the variation in local preferences. Thus, such information could be useful to the Environmental Protection Agency in designing a regulatory solution for the problem of transported ozone pollutants.

thought to affect the location of new rather than existing facilities. Under the Clean Air Act Amendments of 1970, the Congress established geographically uniform new source performance standards (NSPS). Legislators called on the EPA to produce a list of categories of large stationary sources that are subject to regulation under the NSPS.

The federal government can prevent interjurisdictional competition even if it does not set standards that are uniform. It can do so by setting standards that vary among regions. Under the Clean Air Act Amendments of 1977, legislators introduced geographic variation into the NSPS to reflect the differences in the severity of ozone concentrations among locations. For new major sources of volatile organic compounds located in areas violating the ozone standard, the provisions required even more stringent control practices. The Congress also required those sources to offset any increases in emissions with equivalent reductions from other facilities within the area.

Given the federally determined standards for air quality, states do not have the opportunity to choose less-than-optimal ozone standards to attract industry. However, under the Clean Air Act, states have some flexibility in determining abatement levels for each industry. Nevertheless, no empirical or theoretical evidence conclusively indicates that competition for industry leads to less-than-optimal outcomes.

In that context, the performance standards for new sources introduce two other concerns about efficiency. First, NSPS may not benefit society if there is little likelihood that less-than-optimal abatement requirements would result from interjurisdictional competition. Second, imposing more stringent abatement requirements on new sources might cause older, more heavily polluting facilities to stay in operation longer than they otherwise would.

Deciding on Methods of Control

Which level of government can most appropriately choose methods of pollution control? Theoretically, it is the level that can best minimize the cost to society of

achieving a given environmental standard. Of the five considerations discussed in Chapter 1, the primary one in making the choice is information. In general, lower levels of government are best suited for selecting the most cost-effective control technologies because they have greater knowledge of the effects of sources' location and structure on options for reducing ozone. The other considerations, however, introduce possible exceptions to that general rule. Two of those considerations—namely, economies of scale in production and government objectives and capabilities—are potentially relevant to controlling ground-level ozone.

The basic division of responsibilities for selecting controls under the Clean Air Act Amendments of 1990 corresponds in limited fashion to the goal of achieving the maximum net benefits for society. The federal government sets milestones for required reductions of overall emissions—called "reasonable further progress" requirements. It also sets general goals for controlling highly polluting sources—called "reasonable available control technology (RACT)" requirements. At least in principle, states have considerable leeway in choosing specific methods of control in both those cases.

In practice, however, other EPA requirements and guidelines limit choices for states. In some cases, the federal government—not necessarily in keeping with considerations of efficiency—has directed states to adopt specific control methods. Federal intervention in setting required controls on emissions from vehicle tailpipes, however, may be justified based on economies of scale in production. This study also examines vehicle inspection and maintenance programs to assess the argument that inappropriate state objectives or lack of state capabilities or both justify federal intervention in selecting control methods.

Information

In principle, state governments can capitalize on information advantages when they choose control methods to demonstrate reasonable further progress and meet requirements for reasonable available control technology. In practice, states have limited opportunities for choosing a method of control. Federally required control methods under the Clean Air Act limit the choice of control methods that states will use to meet their requirements for "reasonable further progress." For

RACT, states must obtain the EPA's approval to depart from the agency's recommendations for methods of control to limit emissions from certain sources.

Control Methods to Meet Reasonable Further Progress Requirements. The 1990 amendments to the Clean Air Act set general requirements to reduce emissions. Those requirements are geared to achieve the one-hour ozone standard. Most areas violating that standard must achieve a given annual percentage reduction in emissions. No federal requirements exist for specific methods of control that states must include in their plans for achieving those emission reductions. Choices as to the method of control are left to the states' discretion.

Not surprisingly, in formulating plans, states make every effort to use federally required controls, or expected federal control requirements, that the EPA allows them to count toward their reasonable further progress requirements. That strategy contributes to notable similarities in the plans of different states to achieve reasonable further progress. For example, 1996 plans for meeting the ozone standard in Illinois, Indiana, Louisiana, Michigan, Ohio, Texas, Wisconsin, and most states in the Ozone Transport Region all included one federally required control—vapor recovery equipment for refueling. That similarity makes it difficult to assert that the methods chosen by the states necessarily reflect the most efficient options for each area that is employing them to achieve reasonable further progress.

However, some variation in different state plans may more accurately reflect local assessments of the relative efficiency of different control options. For example, Maine opted to take part in the CAA's reformulated gasoline program to achieve reasonable further progress for its Portland area. However, citing high transportation costs for the fuel, the state does not want reformulated gasoline included in its plans to make reasonable further progress for its other two areas that are also designated as moderate violators of the one-hour ozone standard.

Control Methods to Meet Reasonable Available Control Technology Requirements. Reasonable available control technology is another area in which the federal government sets broad emission-reduction requirements for achieving the ozone standard. RACT

refers to the lowest emission limit that a source of pollution can achieve by applying a reasonably available method of control, given technological and economic feasibility. In principle, the states have the discretion to choose the specific methods of control for each source. In practice, however, states receive a fair amount of pressure to adopt EPA recommendations for certain sources.

The 1990 amendments to the Clean Air Act require that states develop rules for RACT for major sources of emissions. However, the EPA issued control guidelines for specific categories of sources. Those technical documents contain extensive background information on control technologies, availability, and cost. Some documents also set forth a RACT emission level for the category of sources in question and analyze whether different control technologies can achieve that emission level.

The EPA develops control guidelines to help state and local air pollution authorities determine RACT. They do not contain explicit requirements for the method of control, and EPA-recommended emission limits are not necessarily binding. Thus, in principle, states are free to decide their own RACT requirements on a case-by-case basis, considering the technological and economic circumstances of the individual source. In practice, however, determinations for certain sources are subject to EPA approval.

In those cases, the burden of proof for not adopting emission levels recommended by the EPA falls on the states. The extent to which that burden of proof constrains states in choosing specific methods of control depends on at least two factors: the proportion of major sources in their jurisdiction covered by EPA guidelines that contain RACT emission levels, and the breadth of control options that can achieve those recommended levels. For major sources not covered by such EPA guidelines, states have more flexibility. They have the discretion either to decide individual rules for each source or to issue a catchall rule that covers the relevant sources.

Some RACT determinations for specific sites reflect local assessments of the relative efficiency of different control options. In Pennsylvania, for example, the state sets RACT target limits for emissions. The individual sources then negotiate with state authorities

to decide the methods of compliance and the actual reductions in emissions that they will achieve.

Economies of Scale in Production

In choosing methods of control for ground-level ozone, the advantages of information highlight the likelihood that lower levels of government will achieve a given standard at the lowest possible cost to society. Economies of scale in production are the consideration with the strongest potential to counter that likelihood. When economies of scale in production prove substantial, a choice of the appropriate method of control by a centralized authority may be the most likely way of minimizing society's control costs. Controls for vehicle tailpipe emissions provide a particularly cogent example of the potential importance of that consideration.

During the early 1960s, the automobile industry successfully opposed federal emission standards for motor vehicles. By the mid-1960s, however, individual state legislation was proliferating. California had already adopted a regulatory program requiring that emission controls be installed on all new cars sold in the state. An auto emissions bill was pending in the Pennsylvania state legislature, and New York was considering a bill on emission standards that was even more stringent than California's. Differing or inconsistent control standards for vehicles set at the state and local level were a big concern for the assembly lines of automobile manufacturers. In 1965, the industry endorsed federal standards to prevent states from setting standards more stringent than California's.

The national tailpipe standards initiated in the Motor Vehicle Pollution Control Act of 1965 allowed manufacturers of vehicles to take advantage of economies of scale in production. The Congress increased the stringency of those standards with the amendments of 1970 and 1990 to the Clean Air Act. The 1990 legislation accepts some variation in tailpipe standards by endorsing California's Low-Emission Vehicle program. Nonetheless, it prevents the proliferation of different product requirements by allowing other jurisdictions to adopt voluntarily only the California LEV program. Requiring a third type of low-emission vehicle program is prohibited.

Note, however, that the existence of economies of scale in production does not imply that controls on tailpipes are necessarily efficient. Nor, given the use of emission controls for tailpipes, do economies of scale in production alone justify federal involvement in establishing a uniform standard for tailpipes.

A uniform, federally determined control on tailpipes would be more efficient than varying state controls under two conditions. First, the net benefits of producing one cleaner car for all areas would have to exceed the net benefits of meeting different tailpipe control requirements in different areas. Whether that was the case would depend on the benefits from exploiting economies of scale, the benefits from widespread emission reductions, and the costs of higher prices of vehicles in areas that would not have required the cleaner car. Second, the transaction costs—both administrative and political—of states negotiating a uniform control would have to be greater than the cost of the federal government's becoming involved.

When might the first condition hold—that is, when might net benefits from uniform tailpipe controls exceed those from meeting different control requirements for tailpipes in different areas? With differing product standards, manufacturers would have to choose between producing different cars for different areas or producing the cleanest car for sale in all areas. Choosing the latter would leave consumers who required that vehicle better off. Because of economies of scale in production, the cleanest car would be cheaper to produce than it would otherwise have been.

However, if the manufacturer raised prices in all areas to recover its average cost, the manufacturer would become vulnerable to competitors. Other companies could enter the market by producing cheaper, higher-polluting vehicles in areas that did not require the cleanest car. That possibility gives the manufacturer an incentive to produce different vehicles for different areas. In evaluating the net benefits to society as a whole, such an outcome could be less than optimal. It would avoid the loss experienced by consumers who live in areas that did not require the cleaner car and who would have had to pay higher prices for vehicles. Nevertheless, possibly outweighing that loss would be the savings from economies of scale and society's benefit from less pollution if everyone drove the cleanest car.

When might the second condition hold—that is, when might transaction costs favor federal involvement? Areas might not have information about which other areas would also be interested in adopting stricter control measures. That lack of information could prevent them from coordinating requirements to take advantage of economies of scale. Alternatively, based on their own costs and benefits, one area (X) might want to adopt a program for clean cars while another (Y) might not. With sufficiently large economies of scale, X would benefit enough from Y's participation to compensate Y for the excess costs it would incur by unnecessarily adopting the cleaner car. For society as a whole, however, the transaction costs of agreeing on controls and negotiating side payments might exceed the costs of a program with federal involvement. The federal role might involve coordinating control requirements through regulation or improving coordination by providing information. Thus, although economies of scale in production alone do not justify having the federal government determine controls, they do signal potential benefits from federal intervention.²⁹

Government Objectives and Capabilities: The History of Inspection and Maintenance Programs

Lower levels of government are generally more likely than higher levels to select efficient control methods. Considerations that introduce potential exceptions to that guideline are economies of scale in production, externalities, decisionmaking costs, and government objectives and capabilities. Vehicle inspection and maintenance programs aim to ensure that over the life of an automobile, its tailpipe emissions conform to the standards associated with its original design. The federal government has had significant involvement in the inspection and maintenance program. Which, if any, of those considerations can best explain that involvement?

The objectives and capabilities of lower levels of government regarding the inspection and maintenance

(I/M) program have raised some doubt.³⁰ Advocates of a strong federal role argue that the I/M program is a cost-effective means of reducing ozone. They assert that states—as a result of either inappropriate objectives or insufficient capabilities—have not adequately exploited those opportunities. Thus, over time, the federal government moved from its 1970 suggestion that states use an I/M program to its 1977 I/M program requirement. That requirement, however, still left program specifications to the states. The federal government's dissatisfaction with state programs during the 1980s led it to establish specific requirements for program design under the 1990 amendments to the Clean Air Act.

One year after the January 1995 deadline for those enhanced I/M programs, only a few of the 23 states required to operate them had begun to do so.³¹ Over the course of the I/M program's history, a few states have—without being federally required to do so—adopted I/M programs that the federal government considered to be efficient.³² Nonetheless, the federal government perceives a significant gap between the achievements of most state programs and the potential for substantive, cost-effective reductions in emissions.

The alternative viewpoint is that states do try to improve the welfare of their constituents and are capable of carrying out appropriate programs. In that view, the states have been appropriately reluctant to establish I/M. In other words, I/M—or certain federal I/M pro-

29. W. Harrington, V. McConnell, and M. Walls, "Who's in the Driver's Seat? Mobile Source Policy in the U.S. Federal System" (paper prepared by staff members of Resources for the Future, Washington, D.C., for the Symposium on Economic Aspects of Environmental Policymaking in a Federal System, Leuven, Belgium, July 1995).

30. Little evidence exists that the other three considerations that potentially justify federal involvement in control selection—economies of scale, externalities, and decisionmaking costs—have in practice prompted federal inspection and maintenance requirements. Of those three, the externalities associated with the transport of ozone precursors is the one that most clearly indicates a need for a federal role. Regardless, considerations of external effects do not appear to have been an important part of the federal government's dedication to setting explicit requirements for the inspection and maintenance program.

31. Susan L. Mayer, *Clean Air Act Issues for the 104th Congress*, CRS Issue Brief IB95034 (Congressional Research Service, January 26, 1996).

32. General Accounting Office, *Better Enforcement of Car Emissions Standards—A Way to Improve Air Quality*, GAO/CED-78-180 (January 23, 1979); Jerome Ostrov, "Inspection and Maintenance of Automotive Pollution Controls: A Decade-Long Struggle Among Congress, EPA, and the States," *Harvard Environmental Law Review*, vol. 8 (Winter 1984), pp. 139-191; General Accounting Office, *Vehicle Emissions Inspection and Maintenance Program Is Behind Schedule*, GAO/RCED-85-22 (January 16, 1985); and Antonio Santos, "MECA I/M Implementation Status Report" (paper prepared for the Manufacturers of Emission Controls Association, Washington, D.C., September 30, 1996).

gram requirements—may not be cost-effective for every state.

CBO considers the validity of three general arguments that would support the view that states' actions on I/M have been the result of their efforts to do what is in the best interests of their constituents. Those arguments are summarized here and are examined in more detail in the appendix.

First, the cost-effectiveness of I/M requirements depends, in part, on one's assessment of the reductions in emissions that are attributable to the program. States may disagree with the importance that the federal government attached to different components of the enhanced I/M program. For example, the federal government focused on the need for centralized inspection facilities in enhanced I/M programs. To avoid potential conflicts of interest, those "test-only" facilities would not offer repairs for emission controls. The federal government also focused on the use of sophisticated emissions testing equipment for every registered vehicle. Critics charge that the EPA's insistence on those requirements is the result of an incomplete assessment of the problem and biased analytic assumptions and methods. Also, the relative cost-effectiveness of any I/M program can depend on the physical characteristics of individual states. Characteristics that can have such an influence are ambient VOC/NO_x ratios, types of sources responsible for emitting ozone precursors, and the importance of the transport of ozone pollutants between areas.

A complete assessment of that argument would require reconciling varying scientific evaluations of the reductions in emissions attributable to the program's implementation and different program characteristics. Those evaluations would probably require additional scientific studies to measure such reductions. Notably, not all states have been reluctant to establish I/M. In fact, some states had successful programs before any federal requirements were put in place. Other states established programs even more stringent than those required by the federal government. Such programs may be cost-effective. Still other states may have valid concerns about adopting program features that may not be cost-effective compared with the alternatives.

Second, states and the federal government may have different assessments of the weight of various fac-

tors in evaluating cost-effectiveness. The EPA recognizes that "I/M programs need to be accepted and supported by the public to be successful."³³ Even so, states argue that the federal government does not adequately account for opposition by consumers and industries.

A more thorough assessment of that argument would require evidence on whether the decisions of state officials are more susceptible to unmerited influence from specific groups representing consumers and industry. The counterargument is that the advantages of state-level information about consumer costs and effects on employment prompt a more accurate measure of cost-effectiveness.

Third, states have also expressed doubt about the cost-effectiveness of committing themselves to federal program specifications that may not turn out to be permanent. However, delays by states in carrying out I/M programs have more likely been the cause of changing federal requirements rather than the result.

Thus, are the objectives and capabilities of lower levels of government sufficient in their choice of control measures in the context of the I/M program? In other words, are states reluctant to establish the programs only because they are not cost-effective? The information needed for a complete assessment of all three considerations that must be evaluated to answer that question is not available.

Determining and Funding the Basic Research Agenda

The threefold division of responsibilities for research on controlling ground-level ozone broadly corresponds to the division most likely to improve the net benefits to society.

First, the federal government is the chief sponsor of research that essentially has the characteristics of a public good. The federal government is also the most

33. Environmental Protection Agency, "Final Rule: Inspection/Maintenance Program Requirements," *Federal Register*, vol. 57, no. 215 (November 5, 1992), p. 52959.

appropriate sponsor of research on the health and ecological effects of ozone, ozone formation in urban areas, and ozone formation and the transport of pollutants among states in the eastern half of the country.

Second, lower levels of government may most appropriately assume research responsibility for environmental problems limited in scope to their jurisdiction. States have built on federal research efforts to understand better the ozone problems particular to their individual circumstances.

Third, the North American Research Strategy for Tropospheric Ozone (NARSTO) is a cooperative agreement between national and state governments and the private sector. Such a framework can address the need for public goods with different types of beneficiaries. Moreover, private concerns can be involved in a process with potentially important effects on industrial activity.

A Strong Federal Role

The federal government is almost entirely responsible for sponsoring research on the health and ecological effects of ozone pollution. It does so through grants and contracts with cooperating research universities in the United States. In 1994, total funding for research on health effects was about \$8 million. The Environmental Protection Agency is the primary sponsor of such research. The agency has focused on clarifying the effects associated with multihour exposure of human subjects to ozone.³⁴ Total 1994 funding for research on ecological effects was about \$3 million. The main sponsors of research on ozone's ecological effects are the Environmental Protection Agency, the Department of Agriculture, the National Park Service, the Tennessee Valley Authority, and the Department of the Interior.³⁵

The federal government has also been a primary sponsor of research to develop photochemical models

of air quality. Analysts use the models to determine the parameters that affect ozone formation and the long-range movement of ozone pollutants. Such models are important tools in examining the effects of alternative control strategies. In the early 1970s, the EPA sponsored three independent studies on model development to identify strategies for emission control to attain the ozone standard in urban areas. Throughout the 1970s and 1980s, the EPA sponsored research efforts to further enhance the most promising model—the Urban Airshed Model (UAM)—and apply it to urban areas.

Another key, federally sponsored modeling effort that essentially had the characteristics of a public good was the EPA's 1977 development of the Regional Oxidant Model (ROM). The ROM effort began after field programs sponsored by the agency exposed the regional aspects of the ozone problem—the problem was not purely a local urban phenomenon. The ROM modeling domain covers the entire eastern half of the United States. Until recently, the ROM was the only tool researchers used to examine extensively the regional effects of emission reductions on ozone concentrations. Lately, building on earlier modeling done under contract to the federal government, Systems Applications International, Inc., developed an improved regional model—the UAM-V. The model is widely used, and the company has made it publicly available through the EPA.

The EPA plans to spend its 1997 appropriation request of \$20 million and 71.2 work-years on a variety of research programs on ground-level ozone. One such program involves continued health studies emphasizing the effects of chronic exposure to ozone. Researchers are assessing both mortality and morbidity using a combination of epidemiological, clinical, and animal studies. In the area of ecological effects, researchers will continue to evaluate the effects of ozone on tree growth. In addition, the EPA's Office of Research and Development will continue research for producing and evaluating the next generation of atmospheric model.³⁶

34. Environmental Protection Agency, *NARSTO Research Strategy and Charter, and Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1996*, EPA 205-R-95-001 (February 1995).

35. Environmental Protection Agency, *NARSTO Research Strategy and Charter*.

36. Environmental Protection Agency, *Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1997*, EPA 205-R-96-001 (March 1996).

States' Research Efforts

In the 1970s, the EPA began advising states on the use of models of air quality in developing state implementation plans. States had a growing interest in applying the UAM to different urban areas to evaluate possible strategies for emission control under circumstances specific to a location. California expressed the first serious interest in the UAM, sponsoring one of several applications to the south coast air basin in 1974.³⁷ By 1990, the federal government explicitly required that states use air-quality models, such as the UAM, in SIPs for almost all areas violating the ozone standard. States use those models to display the link between their regulatory control program and attainment of the standard.

37. Philip M. Roth, Charles L. Blanchard, and Steven D. Reynolds, *The Role of Grid-Based, Reactive Air Quality Modeling in Policy Analysis: Perspectives and Implications, Drawn from a Case Study*, EPA/600/3-89/082 (prepared for the Environmental Protection Agency, May 1989).

Private and Public Cooperation

Participants chartered the North American Research Strategy for Tropospheric Ozone in February 1995, with a 10-year horizon. It is a joint public and private effort to study widespread ozone problems. The consortium of 60 public and private organizations includes state environmental agencies, federal agencies, comparable Canadian and Mexican government participants, the academic community, many large electric utilities, auto manufacturers, and representatives of the oil industry. The effort combines public and private resources. For every \$1 of EPA funding, there are \$2 of non-EPA funding. The EPA requested an additional \$3.5 million in funding for the first full year of the program's existence. The agency allocated those resources to NARSTO research on the effects of ozone on health and ozone formation and control.³⁸

38. Environmental Protection Agency, *Justification of Appropriation Estimates for the Committees on Appropriations, Fiscal Year 1996, and Fiscal Year 1997*.

Conclusions

Which level of government is most likely to make decisions that achieve maximum efficiency in three aspects of environmental protection? The three aspects are:

- o Choosing the extent of environmental control or the level of an environmental standard;
- o Deciding on the methods of pollution control used to meet that standard; and
- o Determining and funding the basic research agenda for an environmental problem.

Choosing the Extent of Environmental Control

The five considerations that affect the relative efficiency of assigning standard-setting authority to alternative levels of government are externalities, information, cost of decisionmaking, interjurisdictional competition, and government objectives and capabilities. The presence of externalities is the key consideration. When all other factors are equal and no significant externalities exist, decentralized standard setting is likely to be more efficient. When all other factors are equal and significant externalities are present, centralized standard setting is likely to be more efficient.

Other considerations, however, may result in important exceptions to that general rule. The need for information points to the advantages of decentralized

standard setting. Alternatively, the cost of decision-making and the potential for destructive interjurisdictional competition underscore the advantages of centralized standard setting. Finally, if governments do not aim to choose standards that yield the maximum welfare for their constituents or are not capable of achieving those standards, assigning them those responsibilities is inappropriate.

The relative importance of other considerations varies, depending on the presence of externalities. When they do not exist, and the advantages of decentralized standard setting appear clear, one must consider the potentially offsetting advantages of centralized standard setting.

Drinking water protection illustrates that situation. Few externalities are involved in selecting drinking water standards. That is, the benefits of protecting drinking water fall primarily on the local population that bears the cost of treatment. Given the general lack of externalities, standards that achieve maximum local net benefits (benefits minus costs) will also achieve maximum net benefits for the nation. Thus, local governments have an incentive to choose efficient drinking water standards.

The need for information further highlights the advantages of local decisionmaking. Local officials generally have better information on unique factors that affect the costs of treating drinking water and the preferences in their community. Federal standards impose welfare losses on communities when they fail to account for unique local circumstances.

Other considerations may, however, reveal offsetting advantages from federal determination of drinking water standards. One such consideration is whether state or local governments would choose—and establish—efficient drinking water standards without federal requirements. State or local officials are not likely to choose efficient standards if they do not have the objective of achieving the maximum net benefits for their constituents. Similarly, efficient standards will not be realized if state or local governments lack the technical expertise or resources to carry out programs designed to achieve such standards. Federally determined drinking water standards may be more efficient than state or locally determined standards under those circumstances.

When externalities point to the advantages of centralized standard setting, the most important considerations are those that might offset those advantages. For example, the need for information points to an important trade-off. Although a centralized standard-setting process can best take into account any externalities, it may lack specific information about the costs and benefits for a particular area. Thus, considerations of information highlight the advantages of setting standards at the lowest level of authority that can incorporate external effects.

Controlling ground-level ozone illustrates that situation. For example, given the transport of ozone from state to state, some individual states and localities lack the incentive to undertake sufficient levels of abatement. Consequently, centralizing the setting of standards would seem to be the best approach. Yet more decentralized standard setting might better capitalize on the information that lower levels of government possess. Given that trade-off, regional authorities or negotiated regional solutions may offer the best way to choose efficient standards. In determining the efficiency of those regional solutions, however, one must calculate the associated transaction costs.

To address the transport problem, the federal government has taken two important steps toward regional decisionmaking. First, the Clean Air Act established an Ozone Transport Commission. The commission has authority to make recommendations to the Environmental Protection Agency on strategies to address violations of the standard within the Northeast. Once the EPA approves those recommendations, all affected

states within the region must act on them. Second, a 1995 policy initiative by the EPA led to the formation of the Ozone Transport Assessment Group. The OTAG worked to achieve agreements through negotiation to address the problem of long-range transport of ozone pollutants across the 38 easternmost states.

The federal government now sets standards for both ozone and drinking water. In both cases, those federal standards might be set more efficiently. For drinking water, the federal government might set standards that better reflect the costs and benefits of different drinking water systems. The 1996 amendments to the Safe Drinking Water Act are a step in that direction. For ozone, the federal government might better use its ability to address interstate externalities. The formation of the Ozone Transport Region and the OTAG were steps in that direction. Furthermore, the EPA has proposed specific emission reductions in states that have been identified as contributing to nonattainment problems in downwind states. If carried out, those reductions may lead to more cost-effective attainment of the ozone standard.

Deciding on the Methods of Pollution Control

Given an environmental standard, which level of government is most likely to choose methods of control that meet that standard at the lowest possible cost to society? The five considerations that affect the relative efficiency of assigning the responsibility for selecting control methods to alternative levels of government are information, economies of scale in production, externalities, cost of decisionmaking, and government objectives and capabilities. Policymakers will want to take all five considerations into account.

However, information on the costs to and preferences of a local community is the primary consideration. When all other factors are equal, lower levels of government are most likely to make the best decisions about methods of control because they have more information about their unique circumstances. The other considerations listed above, though, may lead to important exceptions to that general rule.

For drinking water, the importance of information about preferences and cost as they relate to specific localities illustrates the advantages of allowing water systems to determine their own methods of meeting a given standard. The least-cost control method for drinking water systems may vary based on the size of the system, the initial level of contamination, and the equipment the system already has in place. The circumstances favoring centralized control selection do not generally apply to selecting drinking water control methods.

In theory, water systems have a great deal of flexibility to choose the least-cost method to meet a standard. The EPA does not require systems to use any particular treatment technology. In reality, however, the need to obtain state approval may considerably constrain a system's choices. At least in some cases, states have been reluctant to approve the use of less conventional, lower-cost technologies because of worries about their effectiveness. Although states' concerns may be valid, the general consensus is that water systems would benefit from a streamlined approval process. The 1996 amendments to the Safe Drinking Water Act include several provisions that address those problems. If successful, those provisions should give drinking water systems a greater variety of options to control pollution.

In controlling ground-level ozone, the importance of information points to the advantages of allowing states to determine their own methods of meeting the standard. Officials would then be able to choose methods of control based on the unique circumstances of their state. As for considerations favoring centralized control selection, the one potentially most relevant to ozone is economies of scale in production. That consideration may be particularly important in controlling the tailpipe emissions of vehicles.

The basic division of responsibilities for selecting control methods under the Clean Air Act Amendments of 1990 corresponds in limited fashion to that implied by the goal of minimizing costs. In principle, states have considerable leeway in choosing control methods. In practice, existing EPA requirements and guidelines may limit states' choices. In some cases, those federal requirements are not necessarily in keeping with considerations of efficiency. This study examined vehicle inspection and maintenance programs to assess the ar-

gument that states' inappropriate objectives or their lack of capabilities justify federal intervention in selecting that method of control. However, determining whether the objectives and capabilities of states hinder or aid them in adopting efficient methods of control is difficult.

Determining and Funding the Basic Research Agenda

To develop environmental protection programs that will bring the most net benefits to society, policymakers require information about the effects of pollution on human health and the environment. That information, generated through basic scientific research, essentially has the characteristics of a public good. Thus, the research agenda is most appropriately set and funded at the federal level when its results will benefit many states. Individual states would not have an incentive to undertake a sufficient level of such research because they would not take the benefits to other states into account.

The division of responsibility for research on both drinking water protection and ground-level ozone control is generally consistent with guidelines for efficiency. The federal government plays a key role in research in both areas. In drinking water, for example, the EPA has primary responsibility for assessing the health effects of contaminants found in drinking water. It also sponsors efforts to develop and evaluate treatment technologies—particularly for small systems, which typically face very high per capita treatment costs compared with large systems. The federal government also has primary responsibility for research on controlling ozone. The EPA is the main supporter of research on the health and ecological effects of ozone, and it has been a primary sponsor of the efforts to develop air-quality models.

For both drinking water and ozone, states have conducted research when the benefits fall primarily within their borders. In the case of drinking water, New Jersey has a research program that focuses on issues unique to that state. In the case of ozone, different states have built on federal modeling efforts to improve their understanding of their unique ozone problems. The state

of California, which attaches a relatively high priority to addressing ozone pollution, has supplemented federal research on both health effects and developing air-quality models.

Finally, public/private research efforts have been conducted on both protecting drinking water and controlling ground-level ozone. For example, the federal government provides funds to an association of large private drinking water facilities. That association conducts research on methods to reduce the presence of contaminants in drinking water. Those research results simultaneously help publicly and privately owned drinking water systems, as well as the EPA, to understand the costs of raising drinking water standards.

The North American Research Strategy for Tropospheric Ozone provides an example of a cooperative public/private research effort in controlling ground-level ozone. That effort involves national governments, state governments, and the private sector. Such a framework can address the need for public goods with different scopes of beneficiaries—international, national, or state. It also provides decisionmakers with more information by involving private concerns in a process with potentially important effects on industrial activity.

Is Federal Involvement in Inspection and Maintenance Programs Needed for Efficient Outcomes?

This study examined the considerations that affect which level of government is most likely to make decisions that bring about maximum net benefits to society. One such consideration is whether governments try to achieve maximum welfare for their constituents and have the capabilities (adequate resources and technical expertise) to carry out appropriate decisions.

Assessing the objectives and capabilities of different levels of government is an arduous task. To shed more light on that consideration, this study examined government objectives and capabilities in choosing control measures in the context of inspection and maintenance (I/M) programs. The Environmental Protection Agency's (EPA's) position on the need for I/M indicates that the agency assesses those programs as being cost-effective. If all levels of government try to improve to the utmost the welfare of their constituents and have appropriate capabilities to do so, then the reluctance of the states to carry out those programs indicates that states believe they are not cost-effective. At least three general arguments are made that inspection and maintenance programs—or certain federal I/M program requirements—may not be cost-effective for every state:

- o First, some states argue that the federal government overstates the reduction in emissions that I/M requirements bring about. Thus, the federal government overestimates the cost-effectiveness of I/M requirements. Assessing that argument would re-

quire reconciling varying scientific evaluations of the reductions in emissions that stem from the program and its different characteristics.

- o Second, states and the federal government may have different assessments of the weight of various factors in evaluating cost-effectiveness. States argue that the federal government does not adequately account for opposition by consumers and industries. A thorough assessment of that argument would require evidence on whether the decisions of state officials are more susceptible to unmerited influence from specific consumer and industry groups.
- o Third, states have expressed doubt about the cost-effectiveness of meeting federal program specifications that may not turn out to be permanent. However, state delays in establishing inspection and maintenance programs have more likely been the cause of changing federal requirements rather than the result.

The following material examines each of those arguments in detail. Ultimately, however, the information needed for a complete assessment of all three is not available. Thus, one cannot definitively determine whether states seek to attain maximum welfare for their constituents and have adequate resources and technical expertise to carry out appropriate decisions.

Are Inspection and Maintenance Program Specifications Cost-Effective?

The EPA requirements for enhanced I/M programs included centralized inspection facilities and sophisticated equipment for testing emissions. A higher proportion of vehicles fail inspections provided by centralized test-only facilities, compared with decentralized test-and-repair programs. However, when comparing the effects of centralized and decentralized programs, the limited available empirical evidence suggests that neither vehicle emissions nor ambient air quality differ.¹

Why do more failures at centralized test-only facilities not lead to greater emission reductions? A couple of factors might answer that question. First, both centralized and decentralized programs involve scheduled testing. That requirement gives consumers an incentive to get quick fixes that temporarily improve emissions instead of obtaining lasting repairs. Moreover, consumers can readjust their vehicle after inspection. They may do so if they believe repairs decrease performance, fuel economy, or other attributes that they value. Second, in both types of programs, consumers can potentially use bribes to influence inspectors.²

In addition, evidence shows that whether inspectors use the expensive EPA-recommended test equipment or other emission tests, they can identify largely the same set of vehicles as high polluters. Similar reliability of different tests in identifying the highest emitters is important because half of the emissions come from less than 10 percent of the vehicles on the road.³

Some researchers do not believe that the additional benefits of the more expensive tests are justified by their costs.⁴ For example, remote sensing—measuring vehicle emissions from roadside monitors during normal use—is the test method with the lowest cost per reading. Some researchers and state officials consider scheduled testing of every car as excessive. Most vehicles are in compliance; it is only the highest-emitting vehicles that offer the most cost-effective reductions in emissions.⁵ Using remote sensing to prescreen vehicles for subsequent tests of greater accuracy has another potential advantage. Unscheduled testing provides a direct incentive for consumers to maintain their vehicles so that they are in compliance.

How Do Consumer and Industry Opposition Influence Cost-Effectiveness?

States and the federal government may have different assessments of the weight of various factors in evaluating the cost-effectiveness of I/M programs. Consider, for example, carrying out an enhanced I/M program. States may have better information with which to value nonmarket consumer costs such as time spent on travel to and waiting at centralized test-only facilities. States may also be better able to assess the costs of any reductions in employment as a result of eliminating decentralized test-and-repair businesses.

Alternatively, because of greater political vulnerability compared with federal officials, state officials may give undue consideration to some consumer and industry dissatisfaction. That could occur at the expense of decisions that would result in outcomes that maximize net benefits to society. As for the enhanced I/M program, for example, automobile owners in non-attainment areas subject to the testing requirement may

1. Thomas Hubbard, "Opportunities for Opportunism: An Empirical Examination of the Buyer-Seller Agency Relationships in the Vehicle Inspection Market" (working paper, University of California, Los Angeles, October 1995); Yi Zhang and others, "On-Road Evaluation of I/M Effectiveness" (working paper, University of Denver, 1995); and statement of Donald H. Stedman, Chemistry Department, University of Denver, before the Subcommittee on Oversight and Investigations of the House Committee on Commerce, March 23 and 24, 1995.

2. In decentralized programs, the bribe can be indirect (that is, based on the potential for bringing repeat business to a given facility) as well as direct.

3. Statement of Douglas Lawson, Desert Research Institute, Reno, Nevada, in hearings on the Clean Air Act: Motor Vehicle Inspection and Maintenance Programs before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety of the Senate Committee on Environment and Public Works, June 29, 1995.

4. Environmental Protection Agency, *I/M Costs, Benefits, and Impacts* (November 1992); and Radian Corporation, *Draft Final Report: Evaluation of the California Pilot Inspection/Maintenance (I/M) Program* (Austin, Tex.: Radian Corporation, March 31, 1995).

5. Between 70 percent and 80 percent of vehicles that fail I/M tests are only marginal emitters. Over half of repairable emissions of carbon monoxide, hydrocarbons (a type of VOC), and nitrogen oxides come from only 20 percent of the failing vehicles. Statement of Douglas Lawson.

object to the higher direct costs of testing. The decentralized I/M industry may complain about losing a source of revenue to the centralized I/M industry. Such distributional issues are important. However, as discussed in Chapter 1, the test for whether a policy improves efficiency is whether those who gain from it can fully compensate those who lose.

Maine, Pennsylvania, and Texas suspended enhanced I/M programs in response to consumer dissatisfaction with procedures viewed as time-consuming, producing inconsistent results, damaging to vehicles, and expensive.⁶ I/M proponents argue that the costs associated with such complaints are not significant and that most are the effects of short-lived program start-up difficulties. For example, Colorado and Ohio continued their enhanced I/M programs despite complaints by consumers.⁷ Colorado subsequently testified before the Congress on its solutions to the problems in introducing the new program.⁸ The situation was similar in Ohio, where the state established policies to ease adjustment to the new program.⁹

Industry-specific losses for decentralized I/M businesses may be a more intransigent deterrent to the states' adopting centralized-enhanced I/M testing facilities. State governments may be particularly susceptible to the dissatisfaction of geographically concentrated business owners. For example, California's difficulty in passing enhanced I/M legislation was partly the result of disagreements about how to modify the state's decentral-

alized I/M program. Representatives of the decentralized industry sought ways to retain business revenues provided by the existing program.¹⁰ Passing legislation to improve California's program depended on addressing the "concerns of (the state) legislature and the men and women who (had) invested heavily in (the state's) current Smog Check program."¹¹ In a letter to the EPA, the Governor of California wrote: "As California's Smog Check program employs tens of thousands of people in many small businesses, I am very sensitive to any impact an enhanced program may have on their livelihoods."¹²

Some evidence indicates that states without an established decentralized I/M industry generally had less of a problem in making the transition to the enhanced I/M program. For example, Connecticut and Wisconsin previously had centralized testing systems, and both have experienced comparatively smooth transitions in adopting the EPA's preferred enhanced I/M program.¹³

Does Federal Inconsistency in Program Requirements Jeopardize Cost-Effectiveness?

Some states have expressed doubt about the cost-effectiveness of committing to federal program specifications that may not turn out to be permanent. For example, during the early 1980s, Members of Congress introduced at least eight bills to repeal the I/M requirement in the 1977 amendments to the Clean Air Act. Some states, believing that the Congress would substantially revise requirements, delayed their planned

6. National Conference of State Legislatures, *Clean Air Newsletter* (Fall 1995); Pennsylvania Department of Environmental Protection, "Ridge Signs Bill to Implement Environtest Settlement" (press release, Harrisburg, Pa., December 15, 1995); Pennsylvania Department of Environmental Protection, "Ridge Announces Environtest Settlement" (press release, Harrisburg, Pa., December 6, 1995); Jackie Radcliffe, *Auto Emission Inspection and Maintenance Programs* (Denver, Colo.: National Conference of State Legislatures, Energy, Science and Natural Resources Program, March 1, 1996); Statement of Becky Norton Dunlop, Secretary of Natural Resources, Commonwealth of Virginia, before the Subcommittee on Clean Air, Wetlands, Private Property and Nuclear Safety of the Senate Committee on Environment and Public Works, June 29, 1995.

7. Radcliffe, *Auto Emission Inspection and Maintenance Programs*.

8. Statement of Thomas Getz, Director, Air Pollution Control Division, Colorado Department of Public Health and Environment, before the Subcommittee on Clean Air Wetlands, Private Property and Nuclear Safety of the Senate Committee on Environment and Public Works, June 29, 1995.

9. National Conference of State Legislatures, *Clean Air Newsletter* (Winter 1996); and Radcliffe, *Auto Emission Inspection and Maintenance Programs*.

10. Radian Corporation, *Draft Final Report: Evaluation of the California Pilot Inspection/Maintenance (I/M) Program*.

11. Letter from the California Environmental Protection Agency to the U.S. Environmental Protection Agency, August 26, 1992.

12. Letter from Pete Wilson, Governor of California, to William K. Reilly, Administrator, Environmental Protection Agency, September 2, 1992.

13. General Accounting Office, *Vehicle Emissions Inspection and Maintenance Program Is Behind Schedule*, GAO/RCED-85-22 (January 16, 1985), and *I&M Program Followup*, GAO/RCED-94-292R (September 28, 1994); Radcliffe, *Auto Emission Inspection and Maintenance Programs*.

actions for I/M implementation.¹⁴ In a letter to the states, the EPA also outlined its intent to be flexible in evaluating state implementation plans. The agency further said it was actively working for legislative amendments to extend attainment deadlines and give states greater authority and flexibility. Subsequently, the EPA proposed sanctions against 11 states for not fulfilling their I/M commitments. Three months later, the agency again issued a more lenient policy. States could avoid sanctions if they convinced the EPA they were making reasonable efforts to establish an I/M program.

The I/M requirements in the 1990 amendments provide another illustration of federal inconsistency. The EPA's proposed rule for enhanced I/M granted qualifying decentralized programs immediate provisional equivalency to centralized programs. It also required a subsequent follow-up demonstration proving the decentralized program's effectiveness. However, the final rule required states to have centralized programs unless they could immediately prove that their decentralized program would be just as effective. Despite the final rule, the EPA took a more lenient position with the state of California.¹⁵ Many other states slowed development of their programs while waiting for the outcome of the negotiations between the EPA and California.

Eventually, the agency issued a new final rule. States could put I/M programs into place without the EPA-recommended test equipment and without centralized testing. However, states with decentralized programs would still receive a 50 percent discount in emission-reduction credits when the EPA evaluated their implementation plans.¹⁶ The National Highway

Designation Act of 1995 subsequently prevented the EPA from disapproving an I/M program based on the 50 percent credit reduction. The agency must now presume that decentralized programs are equivalent to centralized programs unless data from two program cycles prove that is not so.

Do those examples support the interpretation that concerns about the cost-effectiveness of meeting impermanent federal requirements have delayed state I/M implementation? An alternative, and apparently more fitting, explanation is that states' reluctance to establish I/M programs has prompted the easing of federal requirements.

Clearly, the federal government met with strong opposition to I/M programs from the states for many years. In the 1970s, for example, the EPA declared that states failing to carry out federal control plans, including I/M, would be subject to enforcement action. Many states—including Pennsylvania, Maryland, Virginia, California, and Washington, D.C.—filed lawsuits in protest. They argued that the federal government's demands were unconstitutional.

For a time, their challenges were successful. The courts labeled the EPA's requirement that states administer federal plans "an impermissible encroachment on state sovereignty."¹⁷ Although the CAA authorized the EPA to issue federal regulations, it did not "direct a state to enact its own statutes and regulations as prescribed by the Administrator."¹⁸ Eventually however, the courts accepted the constitutionality of the EPA's authority in the matter.

Nonetheless, state legislatures posed delays in Nevada during the 1979-1983 period, California during the 1979-1982 period, and Pennsylvania during the 1978-1984 period. State governors also opposed the programs. In 1982, officials from 12 states wrote to the EPA with objections.¹⁹ Even in that atmosphere of states' opposition to I/M, federal inconsistency probably also contributed to delays in implementation. For

14. General Accounting Office, *Vehicle Emissions Inspection and Maintenance Program Is Behind Schedule*.

15. The agency allowed California to implement a program in which the centralized facilities would only test vehicles six or more years old. The state would study the program's effectiveness, and the Environmental Protection Agency would subsequently decide on the need for the centralized program. See the March 1994 Memorandum of Agreement Between the California Environmental Protection Agency and the U.S. Environmental Protection Agency in Radian Corporation, *Draft Report: Evaluation of the California Pilot Inspection/Maintenance (I/M) Program*; and Ralph Haurwitz and Dave McNeely, "The Emissions War," *State Legislatures*, vol. 21 (October/November 1995).

16. Areas adopting a new "low-enhanced" I/M standard, to be met with either a centralized or comprehensive decentralized testing program, would have to achieve the disallowed I/M emission reductions using other methods. National Conference of State Legislatures, *Clean Air Newsletter* (Winter 1996).

17. *District of Columbia v. Train*, 521 F.2d 971, 995 (D.C. Cir. 1975).

18. *State of Maryland et al. v. Environmental Protection Agency*, 530 F.2d 227 (4th Cir. 1975).

19. Seven states opposed I/M because either it was not seen as necessary to achieve the ozone standard or it was not seen as sufficiently cost-effective for all areas. General Accounting Office, *Vehicle Emissions Inspection and Maintenance Program Is Behind Schedule*.

example, the EPA's efforts to be flexible and give states additional time to comply with requirements, instead of immediately proposing sanctions, have in part excused states' I/M delays.²⁰

Conclusion

Is federal involvement in I/M programs necessary to achieve efficient outcomes? In principle, individual states can choose from a variety of controls to achieve the ambient air-quality standard for ozone. Considerations of efficiency indicate that allowing states to select controls will generally be more cost-effective than having the federal government prescribe specific control methods. The argument for federal involvement in I/M programs is that all state governments do not have the objective of making cost-effective choices, or that they are not equally capable of making cost-effective choices. To begin to verify that argument, one must assess at least three claims.

First, in the case of communities subject to federal I/M requirements, states might be ignoring cost-effective opportunities to combat ozone pollution. That would have to be true despite specific physical characteristics of different areas that are influencing problems of ozone nonattainment. Without reconciling varying

scientific assessments of the relative cost-effectiveness of I/M programs, it is not possible to tell whether that claim is valid.

Second, state governments may place inappropriate weight on the opposition of consumers and industries to I/M programs in assessing their relative cost-effectiveness. State governments may have better information than the federal government about nonmarket consumer costs and effects on employment. Alternatively, with issues like I/M, state officials may be more politically vulnerable than federal officials. Thus, one might also conclude that state governments are more susceptible to undue influence from specific consumer and industry groups. That may encourage decisions that are not cost-effective for the state's constituency as a whole.

Third, frequent changes in federal requirements might not significantly affect the cost-effectiveness of carrying out I/M programs. Alternatively, states may bear unnecessary costs if they implement federally required programs and then have to conform to changed program specifications. Ultimately, however, states' delays in establishing I/M programs were more likely the cause of the changing of federal requirements rather than the result.

Those three claims have played important roles in the debate over the cost-effectiveness of I/M. Based on currently available information, one cannot clearly establish their validity. Thus, in the context of the I/M programs, one cannot draw definitive conclusions about states' objectives and capabilities. It follows that one cannot assess the likelihood that state governments would make decisions about methods of controlling pollution that maximize net benefits to society.

20. Ibid. The General Accounting Office found that the threat of sanctions was the direct cause for the decisions of some states—such as California, Indiana, North Carolina, Illinois, and Michigan—to implement I/M pursuant to the 1977 amendments in spite of their opposition to the program.